AVIATION AND AERONAUTICAL ENGINEERING

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AUGUST 1st 1917

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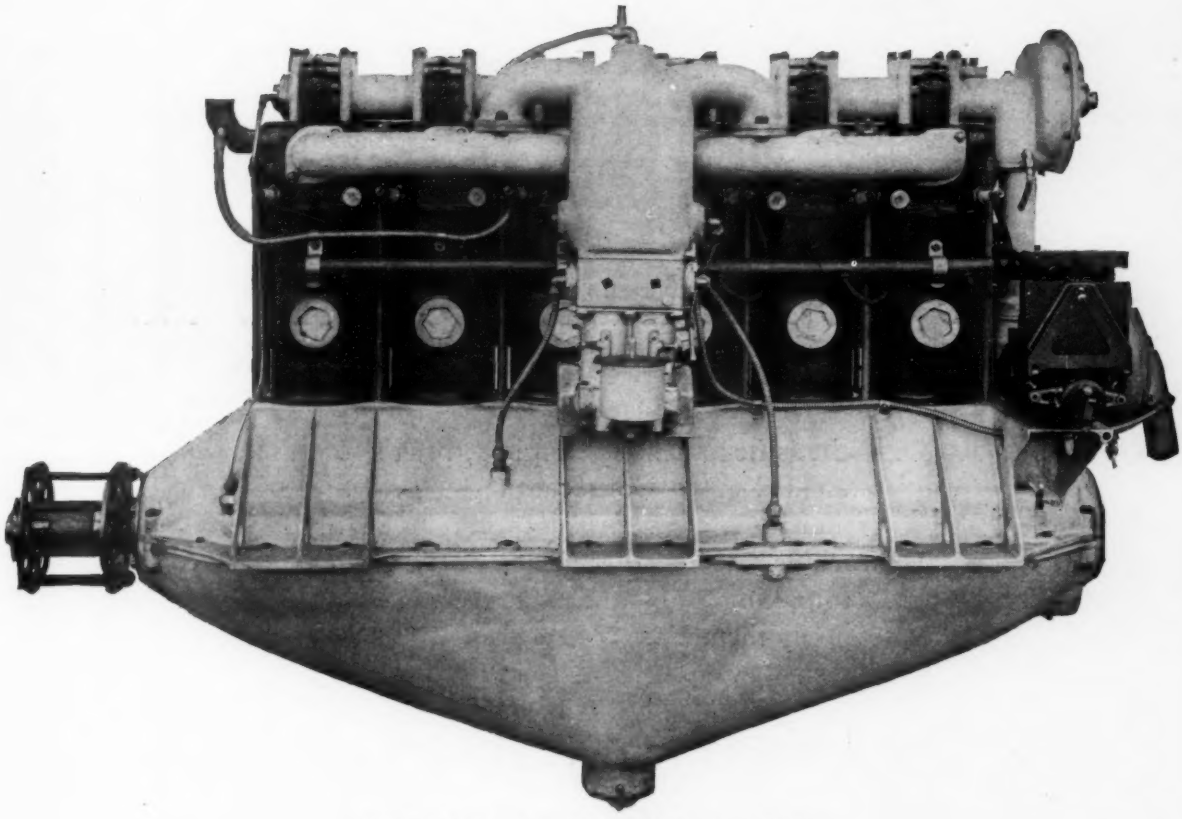

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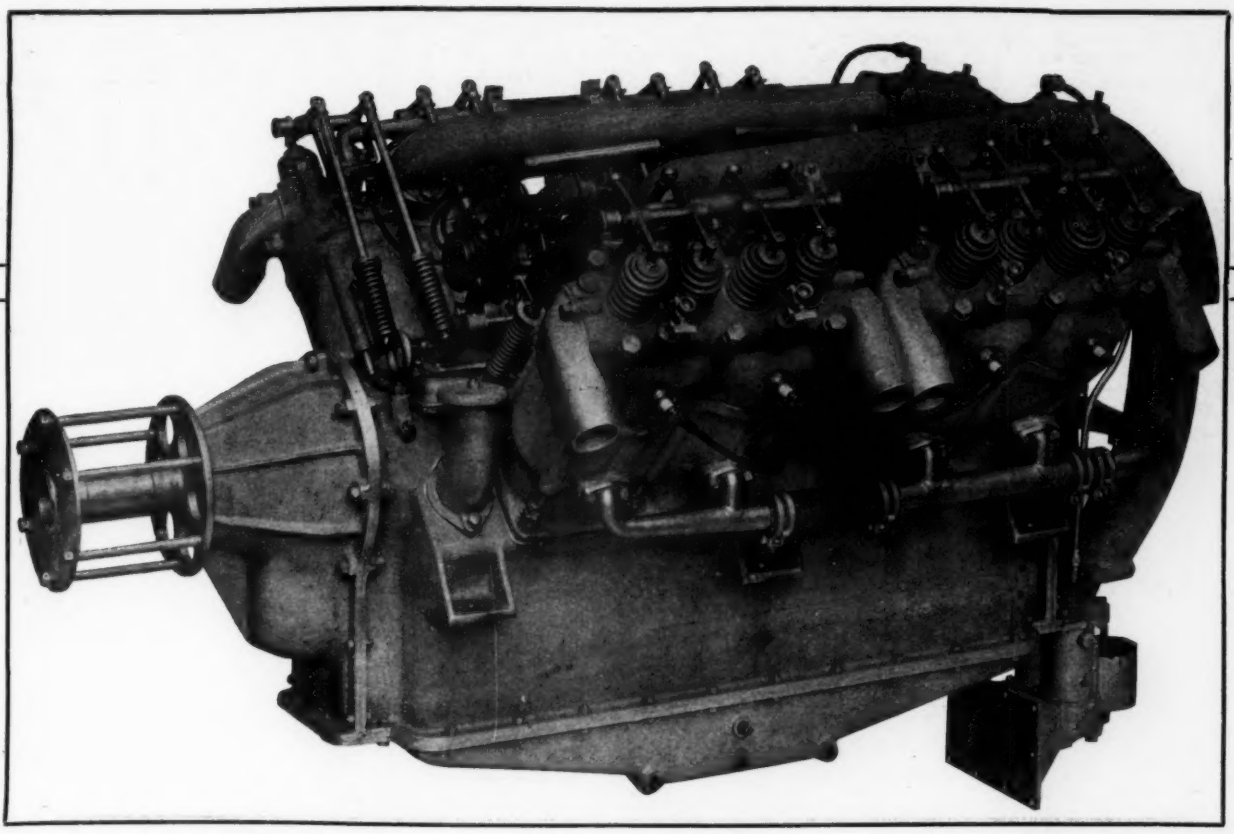

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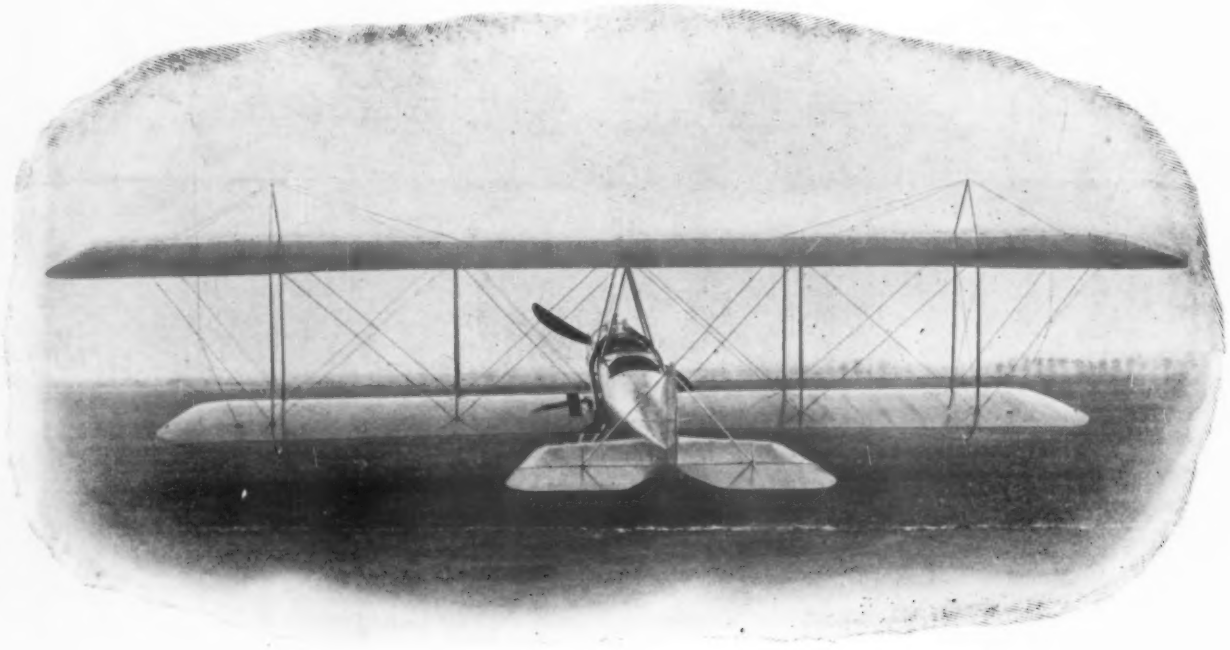

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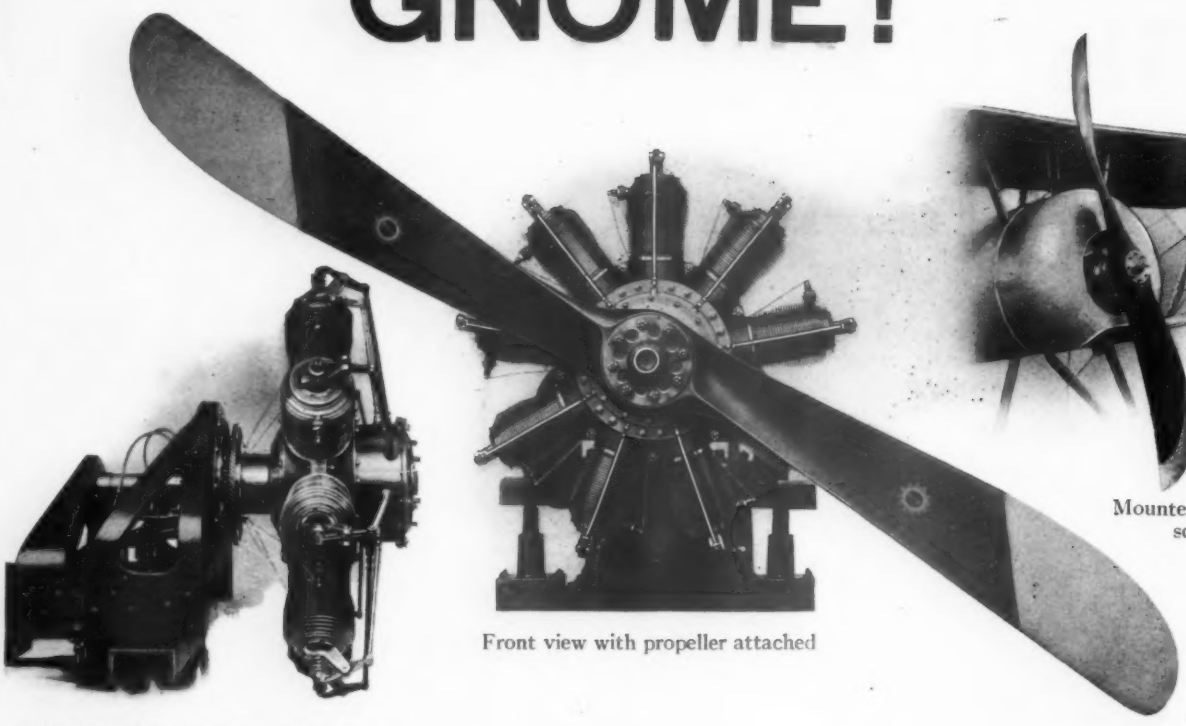
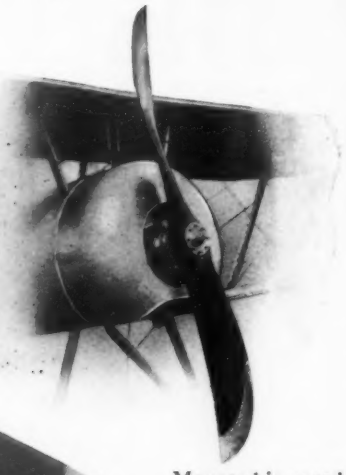


Side view of engine mounted for test

Front view with propeller attached



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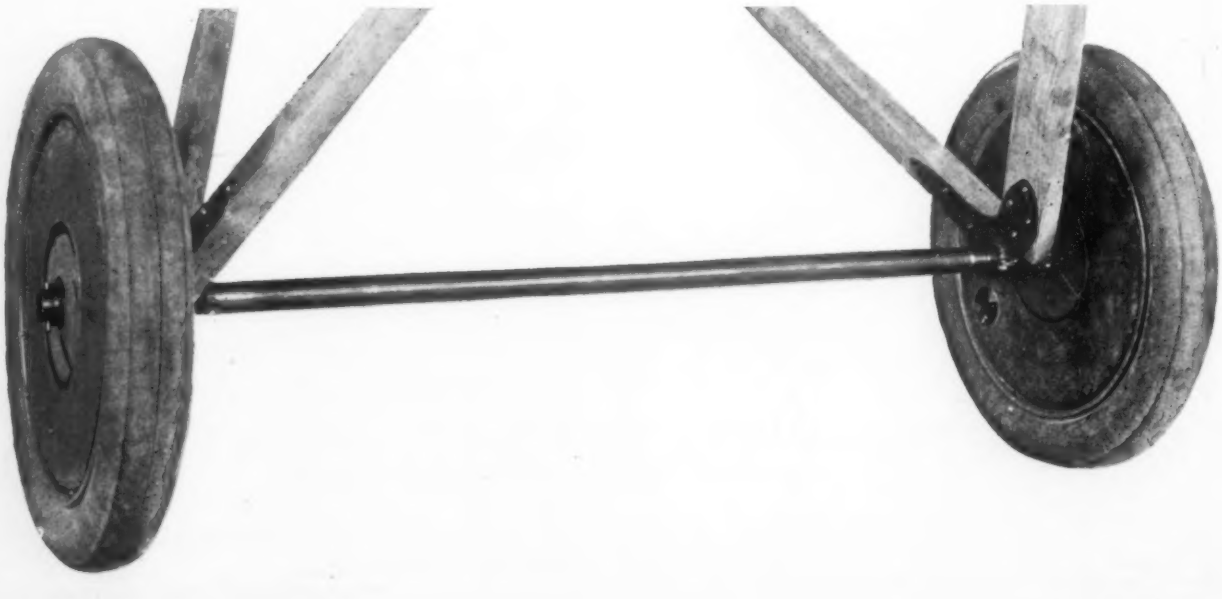
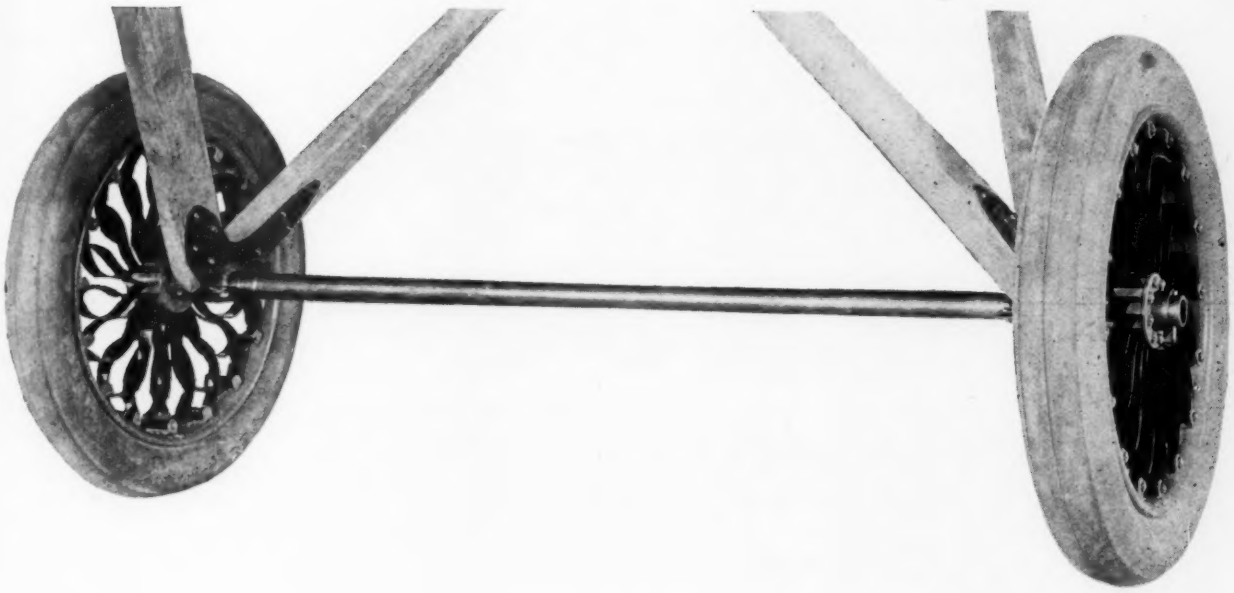


THE MODERN AIRPLANE



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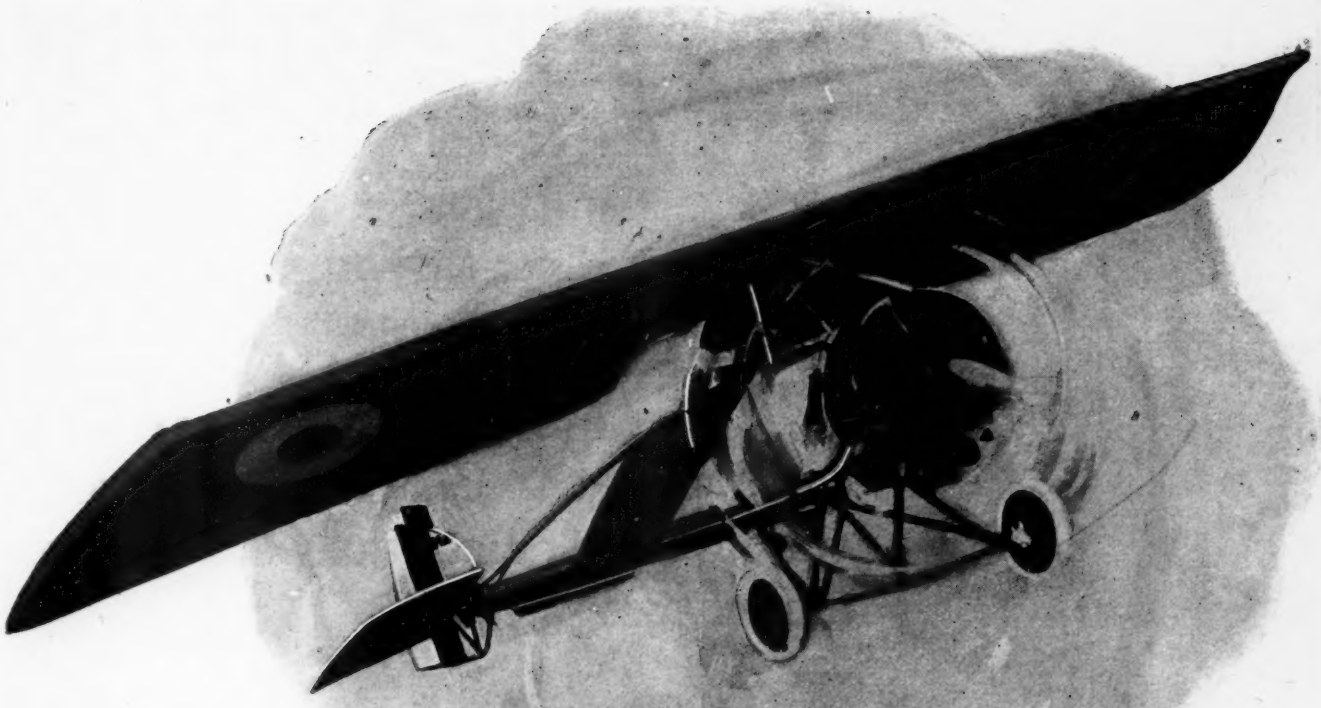

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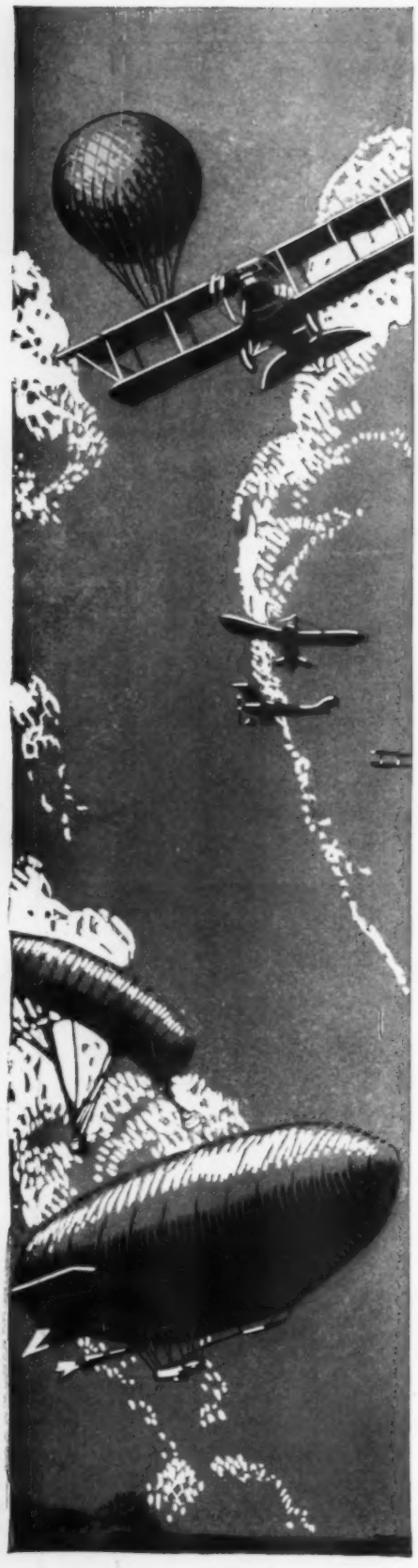

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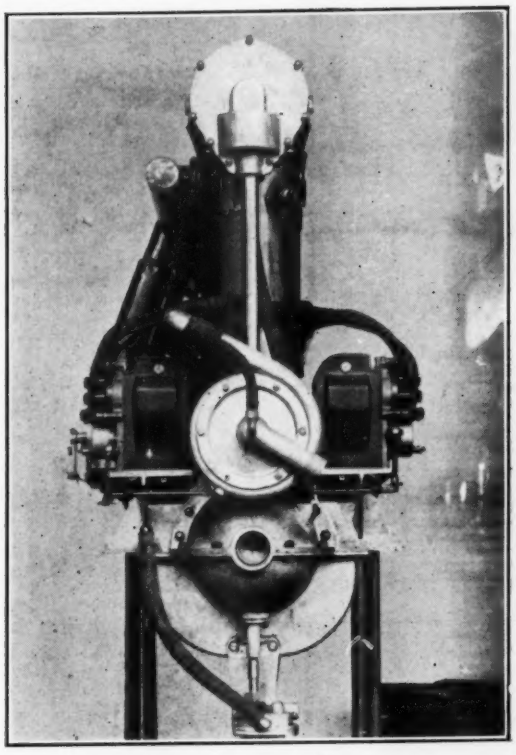

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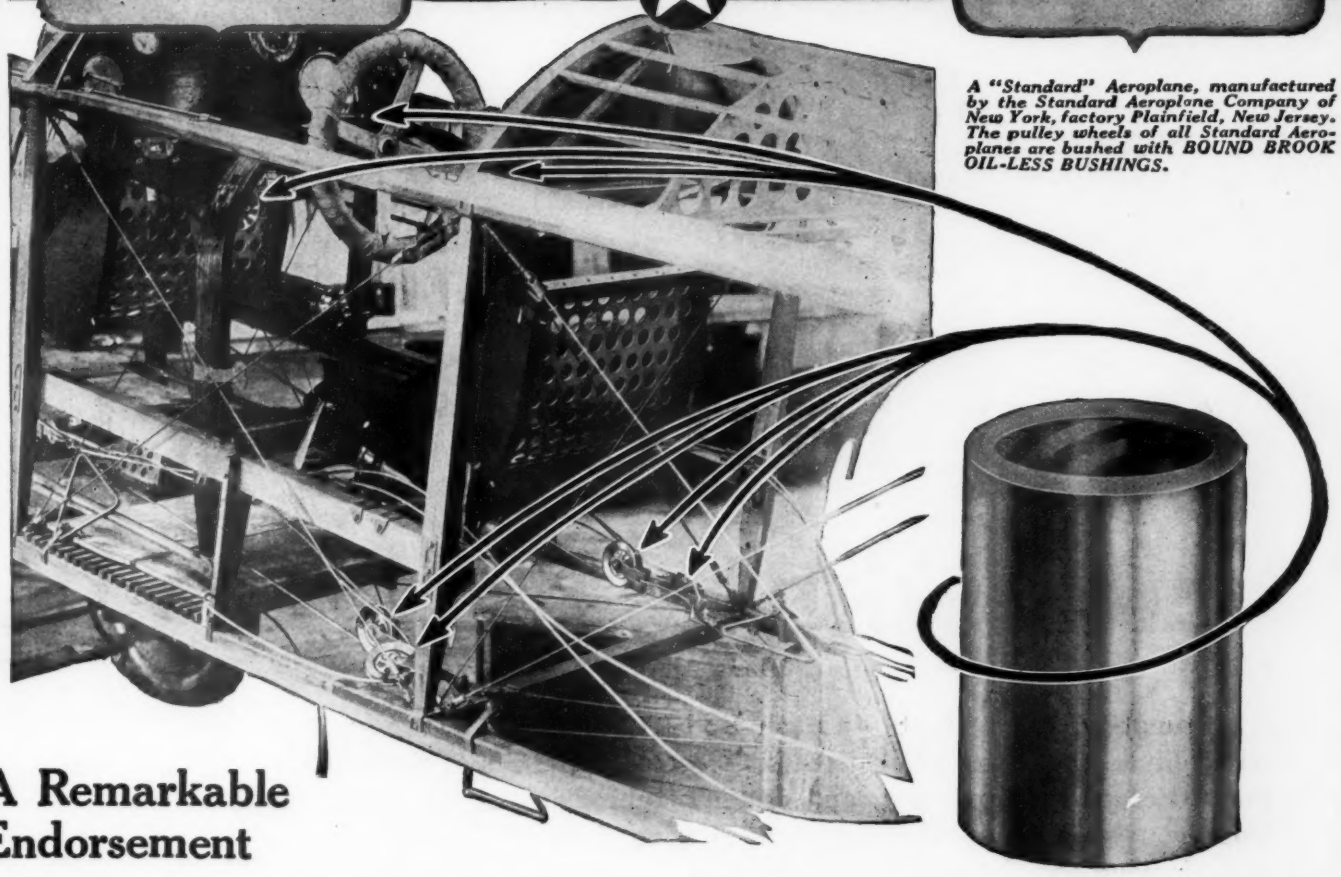

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A Remarkable Endorsement

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Should a pulley wheel bushing stick or jam it might spell catastrophe for the operator. Yet these little pulleys are continuously exposed to the action of the elements. At flying heights—18,000 feet at times—the planes repeatedly rush through dripping clouds of rain and moisture. It is vitally important, therefore, that any type of anti-friction bearing which might corrode or rust should not be used for the pulley wheel bushings. Many types of bearings cannot resist corrosion or rust under such conditions. It is impossible to keep them continuously oiled when flying at different angles. Plain bearings, for similar reasons, are objectionable.

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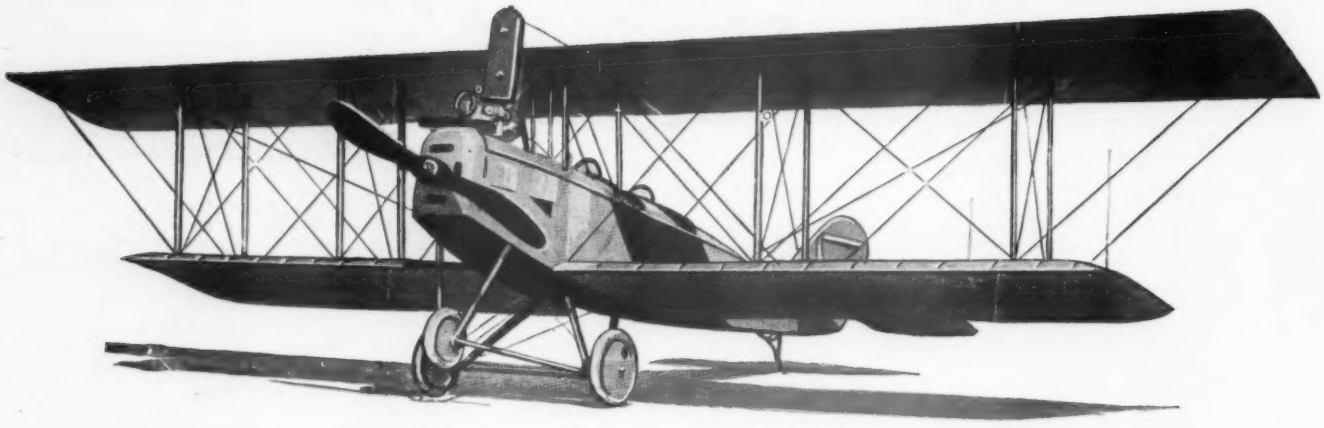

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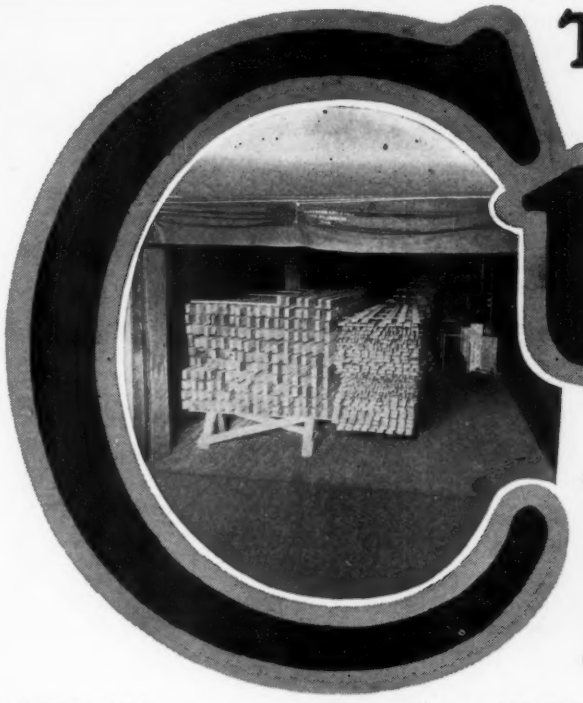

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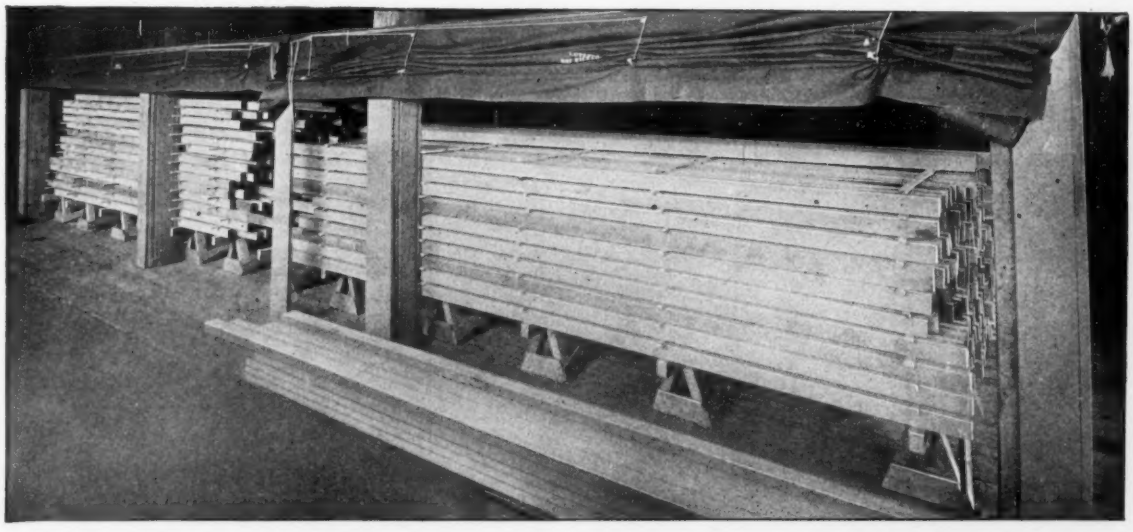

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AUGUST 1, 1917

AVIATION AND AERONAUTICAL ENGINEERING

VOL. III. NO. 1

Member of the Associated Business Papers

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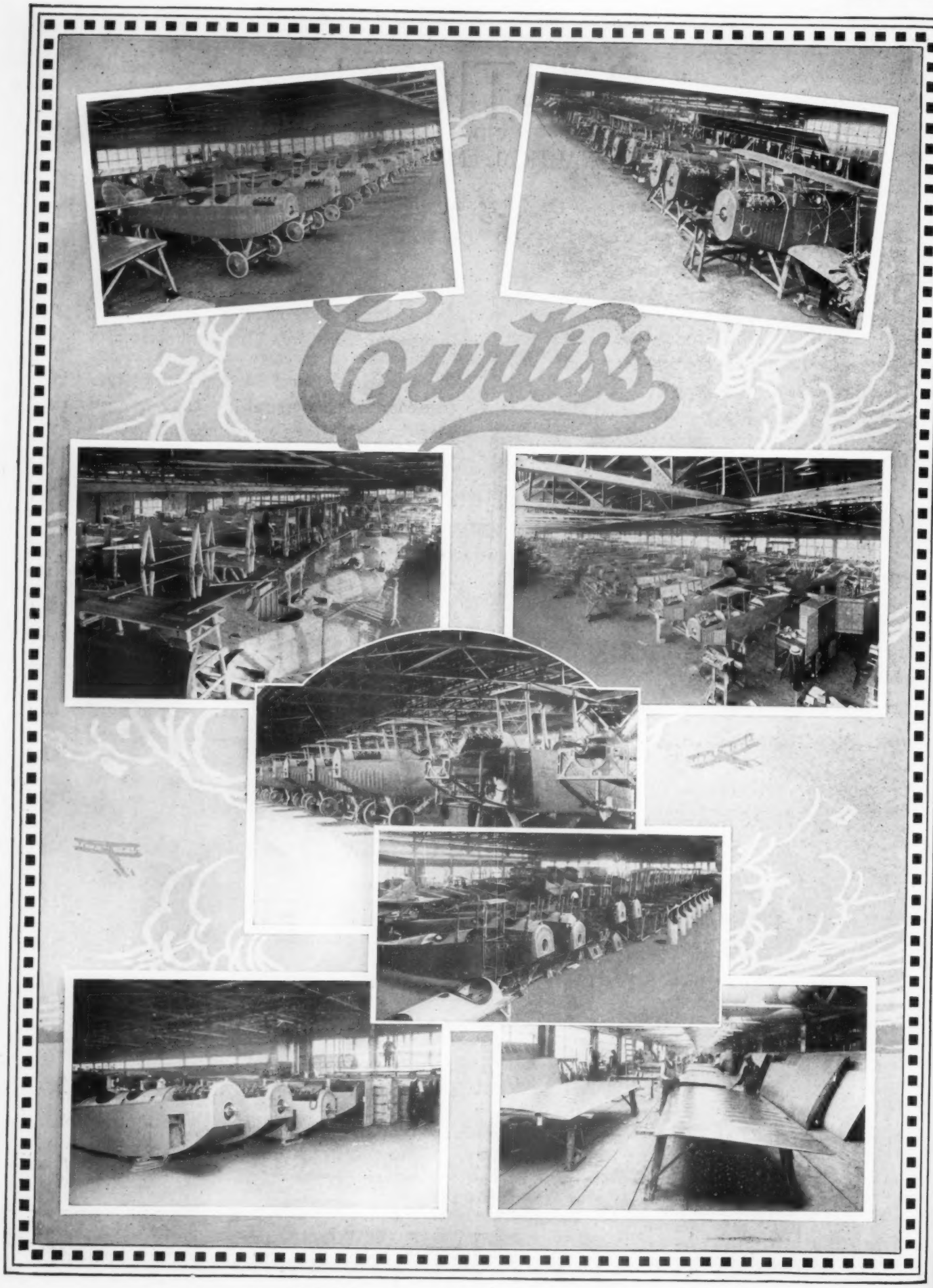

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AVIATION AND AERONAUTICAL ENGINEERING

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Massachusetts Institute of Technology

BUSINESS MANAGER
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Vol. III | August 1, 1917 | No. 1

WITH this issue AVIATION AND AERONAUTICAL ENGINEERING enters upon its second year. It would be an impossible task to condense in a short editorial even the most important events which have occurred in aviation during the past twelve months.

A year ago, in this country, military and naval aeronautics were just beginning to be taken seriously. Congress had become convinced that the United States was one of the weakest powers in the world in the air, and that due attention to this important and newest branch of national defense had been neglected. A start was made with appropriations for the Army and Navy, which now seem ridiculously small. The amount set aside, however, was large enough to enable constructors of airplanes and engines to be given small orders and receive more or less encouragement from the Government, and not have to rely entirely upon foreign orders to keep their business going.

The creation of an Aviation Section of the Signal Corps with Brig.-Gen. George O. Squier at its head was also an important factor in the rapid development of military aeronautics in this country. Gen. Squier has had the imagination to grasp the magnitude of the air service which the country must have in order to play a successful part in the war, and to deliver the final thrust at Germany through the air. To him, perhaps more than to any other man, is due the success of the program which has just been approved by Congress and the President. His earnest and convincing testimony before the Congressional committees holding hearings on the aviation bills, did more to enlighten and inform the members of the committees than any other single feature.

The Aircraft Production Board and its chairman, Howard E. Coffin, have also been of the greatest importance in the work of creating a favorable public sentiment, and the importance of the work of this Board in assisting to put into effect the plans of the Chief Signal Officer cannot be overestimated.

By its statements to the public and by the effective and continuous publicity of the Aero Club of America, the people of this country have been aroused to the needs of an adequate air offensive in the war.

The Navy with its usual policy of silence has prepared a program which will lay a foundation for a naval flying corps for coast defense, submarine searching and scouting. Many sites for stations have been selected and rapid progress is being made in erecting the necessary buildings and supplying flying equipment. Experimental work is also under way which may produce types of airplanes peculiarly adapted to naval work.

The work of the officers of the Allied commissions now in this country should also be praised. These experts have done much more to assist in our work than will be realized until after the war is over. They came to this country armed with facts and figures, which were used where they would do the greatest good, and their sincerity and earnestness have impressed all with whom they have come into contact.

The airplane industry in this country has found itself at last; it has organized and through the joint action and cooperation of its members has solved many of the difficult problems which have been obstacles in the past. The industry with a fine spirit has been assisting the new concerns which have been called on to aid in the production of airplanes and engines.

Congress, in passing the $640,000,000 aviation bill without prolonged debate, has rendered our allies a real service. Representatives and Senators have with a unanimity which is unique in the history of large appropriations, given their wholehearted support to this bill, the President signed it immediately, and Gen. Squier and his staff now have available an adequate amount with which to make a beginning of providing the United States with an air fleet worthy of the country.

The Patent Situation Settled

The cross-licensing agreement which has been entered into by the aircraft manufacturers is a long step toward progress in clearing the way for rapid expansion and freedom of action. It is a matter of congratulation that litigation has been avoided at this time. The National Advisory Committee for Aeronautics, which has been instrumental in helping the adjustment of difficulties among patentees, has done a remarkable piece of work very quietly. The effects of this settlement will also be to bind the aircraft manufacturers closer together, as the arrangement as made involves financial considerations which will eventually run into the millions. Now, any patentee with an improvement which is of value to the industry, can have his patent used and receive compensation therefor which will be just and equitable.

The Next Volume

Despite the fact that the censorship of news is properly becoming more and more strict, AVIATION AND AERONAUTICAL ENGINEERING believes that during the coming year the technical information which it can supply to readers will be practical and helpful. A mass of engineering data which has never been published and which can have no effect in a military or naval sense is becoming available and will be of the greatest use to constructors and designers.

The Type F Dirigibles of the Societá Leonardo da Vinci

The "F" type of dirigible belongs to the semi-rigid class. Its main characteristic features are:

Double envelope.
Gas envelope fitted with transverse and longitunal diaphragms.
Rigid truss girder running in the direction from stern to bow.
Axial suspension of the girder from the balloon.
Arrangement of the car close to the envelope and rigid suspension of the same from the truss or reinforced girder.
Stiff bow, the bow stiffening being solid with the reinforced girder.
Flexible steering surfaces of grate-like construction.
Splitting of the propelling apparatus in quite independent sets.
Screw-propellers with adjustable reversible pitch.
Upper platform fitted with shaft (or pit) and ladder for connection with the car.

The present summary description of the above arrangements

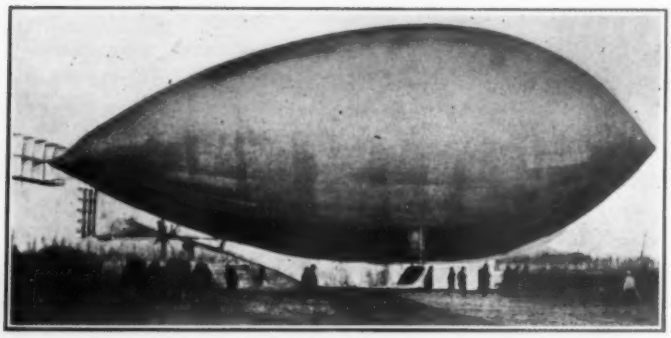


FIG. 1 AN EARLY TYPE, THE LEONARDO DA VINCI F1

is illustrated in the drawing, Fig. 11, showing the 15,000 cu. m. F 4 dirigible, that was built recently and passed through its contract trials most successfully.

Double Envelope

The envelope of the "F" dirigible consists of an inner or gas envelope and of an outer one that surrounds the former completely, a continuous and entirely free air space being left between the two. This space, the bottom portion of which forms the air compensation chamber, is maintained under pressure while traveling. Owing to this arrangement:

(a) The gas envelope is efficiently protected against the heat and chemical action of the sun's rays, a most important condition for airships intended to travel at high altitudes during daytime;
(b) The gas envelope is relieved from all stresses due to the sailing velocity, these stresses being taken by the outer envelope;
(c) The outer envelope, being a plain air-tight construction, can be made very light, even when it has to withstand relatively high internal pressures (high velocity dirigibles);
(d) The external form of the dirigibles is a regular one and therewith free from additional head resistances. Further the external form is not materially altered when any compartment of the gas bag gets emptied and the airship can sail on regularly in case of damage to the gas envelope.

The outer envelope is plain varnished silk and, in order to prevent the danger of large gashes being formed, it is strengthened by a large number of closely set longitudinal and circumferential bands fitted to its inner surface. Suitable arrangements are provided for connecting the inner and outer envelopes with one another and for maintaining them in their correct relative position.

The outer envelope is connected by two catenary bands to the underside of the truss girder and thus actively contributes, when it is under pressure, to the general rigidity of the whole airship.

The bottom of the outer envelope can be readily opened longitudinally and tucked up for the purpose of inspecting and repairing the girder, the suspension means and gas envelope.

Partitioned Gas Envelope

The inner or gas envelope is fitted with gas-tight cross diaphrams, by which it is divided into numerous, independent gas-proof-compartments. These transverse diaphragms intersect eight longitudinal, likewise gas-tight, partitions radiating from the geometrical axis of the airship and reaching to the outer surface of the gas envelope.

Along the center line, where the longitudinal partitions meet, a strong axial band is thus formed. This band is called "the suspension band" owing to the fact that the rigid girder is suspended from it by a rope system. Thanks to this arrangement:

(a) The gas mass is subdivided into numerous compartments and efficiently checked; so that the stability remains a good one even during the descent from high altitudes;
(b) The cross section of the envelope remains practically invariable in its upper portion whatever be the condition of inflation. This condition, which means that the airship is no longer subjected to increases of its height, greatly facilitates the connection of the two envelopes with the girder as well as the arrangement of the upper platform and of the shaft connecting the latter with the car.
(c) The canvas stresses, which as already stated are due only to the static pressure of the gas mass inside of it, are very small and thus allow of the envelope being made relatively very light. To the attainment of this most important result are contributing also the double envelope arrangment and all the constructural details of the airship.

The gas envelope is made entirely of silk, plain natural silk being used for the longitudinal partitions, plain gummed and varnished silk for the cross diaphragms, double diagonal gummed and varnished silk for the outer envelope and ninefold for the axial or suspension band. The use of silk canvas, gummed by a process enabling its final proof-making by varnishing is a specialty of the Societá Leonardo da Vinci.

The described general construction of the envelope allows an arrangement of operating ropes radiating from the axial or suspension band. The efficiency of so arranged control ropes when maneuvering from the ground is actually noteworthy and far better than when the rope attachment lies below the center line of the airship, as is the case in other dirigibles.

Each gas compartment is fitted with all the necessary mountings, the main one being the gas relief valve. These valves, of which there is one for each compartment, serve both as safety and as control valves; for the former purpose they are directly operated by the canvas of the bottom portion of the envelope through a rope; for the latter purpose they are operated pneumatically.

In order to inflate the airship, the gas envelope is spread out on the ground and the outer envelope fixed on it by provisional ties. While inflating, the envelope is held in place by means of ballast bags suspended from hooks provided for this purpose and suitably spaced along the equatorial line of the envelope; the inflation is therefore effected in quite a similar manner to that of Drachen balloons. When the envelope is a little more than half filled, it is suffered to rise sufficient for slipping the rigid girder under it; the envelope is then secured

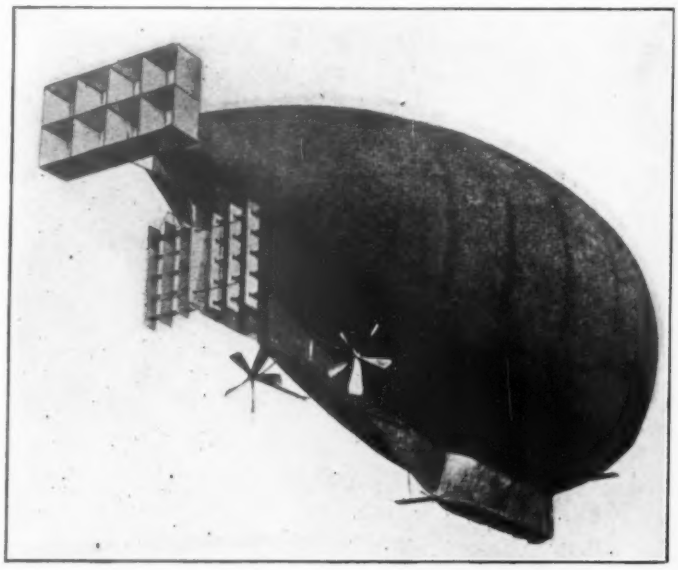


FIG. 2 AN EARLY TYPE, THE LEONARDO DA VINCI F1

to the girder and the filling pursued and completed. The operation is easy and quick to perform.

Truss Girder

This is an entirely rigid lattice girder running from end to end of the airship, and arranged between the two halves into which the bottom portion of the gas envelope is divided. Nearly the whole girder length remains inside of the outer envelope, whose shape it approximately suits.

The girder is built up of steel tubes braced with diagonal steel wires or wire ropes, and serves to support the car, rudders, bow stiffening ropes and eventually also the rigid bottom section of the shaft connecting the upper platform and the car.

This girder is designed to stand, not only all the static and dynamic stresses that may set in under ordinary sailing conditions, but also any stresses that may arise from pitching or uneven distribution of load consequent on any of the gas compartments becoming untight and letting out the gas. With a view to fulfilling this condition, which is of paramount importance in Army airships, the main girder has been made rigid throughout.

Axial Suspension

The connection between the girder and the envelope is effected by means of wire-rope sets leading in pairs from the junction knots in the upper side of the girder to the under side of the suspension or axial band, the bottom edge of the band consisting of a series of small catenaries.

The ropes of the suspension system show a very pronounced inclination to the vertical in order to secure the connection remaining unaltered, notwithstanding the heaviest pitching.

In addition to the main connection just described further lateral connections are provided, the same being so arranged as to secure the indeformability of the top portion of the gas envelope, notwithstanding its varying gas pressure.

Rigidly Suspended Closely Adherent Airship Car

The airship car is a rigid framework of similar construction to that of the rigid girder. The car is suspended from the girder knots by rigid tubular connections, thus forming with the girder a single rigid system. This arrangement enables a ready setting up and eventually the fitting of the rigid connecting shaft (or pit) it further greatly contributes to the compactness of the whole, a feature which is of great utility as well in sailing as in respect to maneuvering from the ground.

The car is arranged close to the outer envelope and nearly in touch with it; almost the whole of the car is closed in with glass or with spread canvas according to the position concerned.

All these arrangements efficiently assist in lowering the resistance to flight.

Stiffening of Front Portion of the Envelope

The object of this stiffening is to permit of an appreciable reduction in the pressure of the outer envelope relatively to the external aerodynamic pressure. The stiffening frame also serves to receive the air-intake valves, the object of which is to keep up the internal pressure while traveling.

The stiffening frame consists of a rigid calotte, from which a set of slightly elastic bars extend to support the front portion of the outer envelope and take up the reaction of the external air. This sort of umbrella is rigidly supported by the girder so that even wind gusts cannot deform the front of the envelope or press it inwardly.

The air intake valves admitting air into the air chamber consists of a large number of balanced blades, arranged in the center of the rigid calotte; the working of these blades is free from shaking and rattling.

Beside the air inlet just described there is an automatic air-relief arrangement, the object of which is to prevent excessive pressures in the air chamber. This objeet is achieved by means of automatic valves arranged at the rear of the airship in a zone where the areodynamic influence of velocity is practically nil.

The complex of these arrangements and the dimensions adopted for the air and gas valves enable high speeds in the ascent and descent—up to 1000 meters in five minutes—without need of the pilot ever minding the gas or air chambers and yet without appreciable pressure variations taking place in these chambers.

A fan, which is kept running only during the maneuvers from the ground, serves to maintain the outer envelope under pressure and prevent its deformation, when this cannot be performed by the front air-intake valves.

Flexible Gratelike Steering Surfaces

The steering surfaces of the "F" dirigible are generally arranged in two sets: one for the dynamic compensation of the natural variations in the static equilibrium, this set being built up of horizontal surfaces forming two symmetrical grates carried from the car not far from the airship's center of gravity, and the other for steering the ship horizontally and vertically, this set being built up of vertical and horizontal surfaces forming two symmetrical grates which are carried from the girder and arranged at the stern.

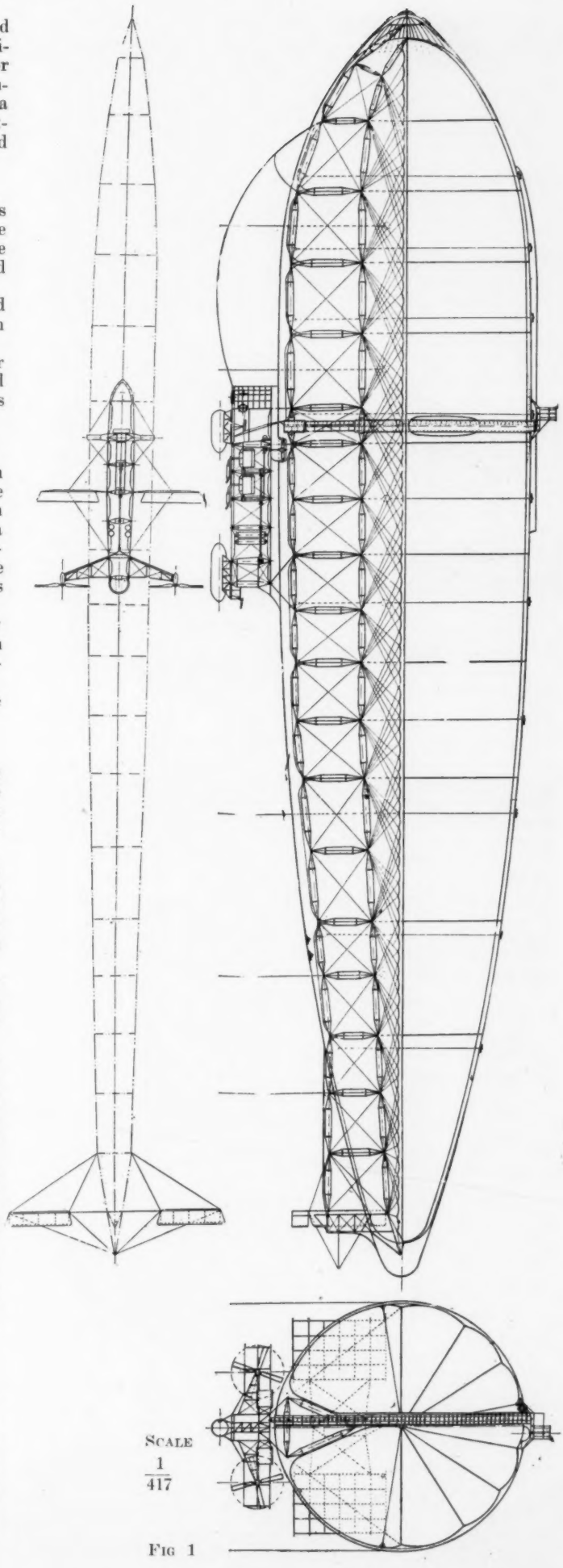


FIG 1

The former set represents a maneuvering convenience rather than an actual necessity and can accordingly be dispensed with, a small advantage being thus realized in weight and speed.

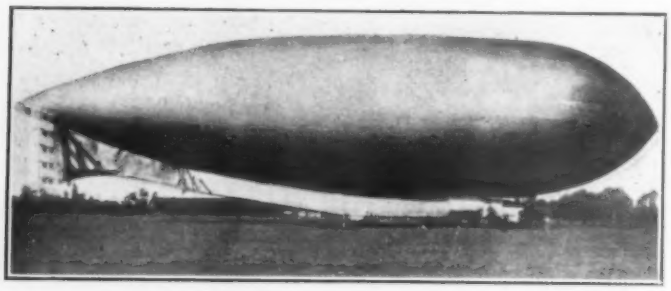


FIG. 3 DIRIGIBLE F2, CITY OF MILAN

The characteristic feature of these surfaces is that they are not stiff and do not swing round an axis, as is the case with all other rudder types, but are flexible and have their front edge rigidly secured in the respective grates, the controlling means being attached to their rear edge.

When operated by the pilot and bent, these surfaces are cambered like airplane wings, the efficiency being very high with small bendings and still good with greater bendings.

The controlling of these surfaces is always effected through the intermediary of an irreversible worm gear.

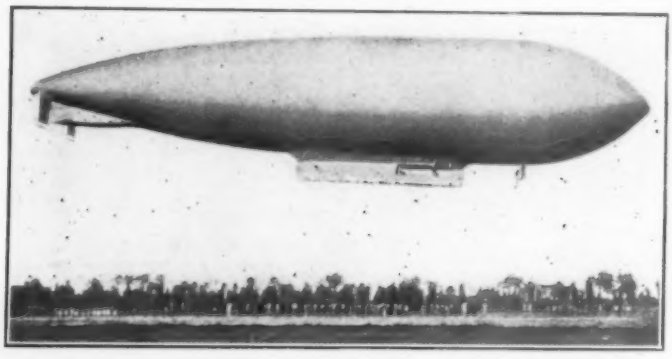


FIG. 4 A SIDE VIEW OF THE F3

These surfaces built up grates of simple and compact construction giving rise to but a small amount of passive head resistances.

The described arrangement of the steering gear coeurs in keeping low the total head resistance even when, the air being violently agitated, the operation of the rudders is hardened.

Propelling Apparatus

The best arrangement thus far designed appears to be that of dirigible F.5 now in process of construction. This dirigible is fitted with two engines arranged on the center line of the car, each of them driving a propeller through a friction clutch and a set of wheel gears, the two sets being connected together by a gear box so as to cause, the motion of the two propellers to be perfectly alike, and to enable both propellers to be driven by a single engine, or either propeller to be driven from the engine which is ordinarily intended for the other propeller.

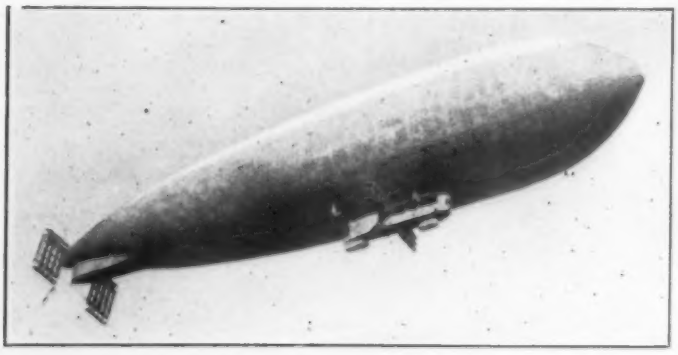


FIG. 5 A LATER TYPE, THE F4

Close to each engine is arranged the corresponding radiator, fitted with adjusting screen and directly coupled fan supplying the necessary air stream also for a ventilated hood surrounding the engine, to prevent accumulation of gases. Each engine is also fitted with oil cooler, exhaust cooler and silencer.

When either of the engines is accidently stopped, it can still be kept hot by means of pipes leading from the running engine. This arrangement facilitates restarting, saves the time which should otherwise be spent for running the engine up to full power, and obviates the danger of the water and oil freezing at the low temperatures obtaining at the higher elevations.

In the "F" dirigibles the auxiliary apparatus such as air chamber fan, lighting dynamo, compressed air pump and intermittent switch for the route lanterns, are driven from a special shaft, the motion of which is secured by either engine without need of any interference by the pilot.

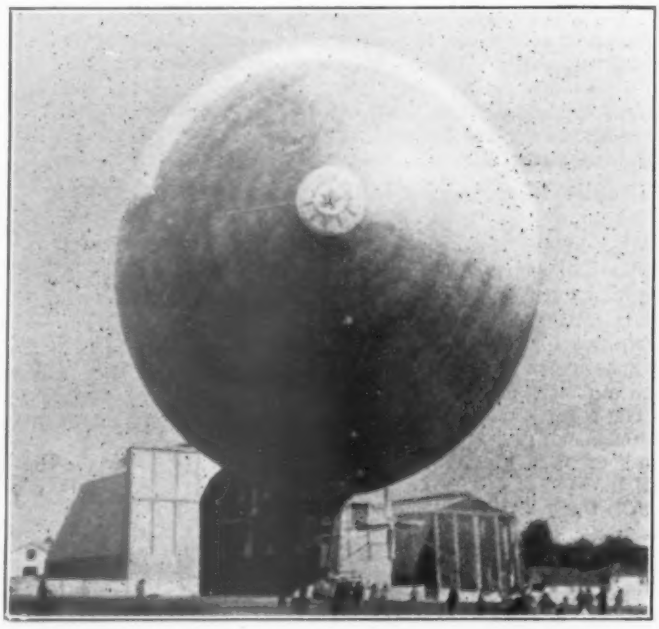


FIG. 6 THE AIR INLET ARRANGEMENT CAN BE SEEN

The compressed air supplied by the small pump just mentioned serves for the pneumatic control of the valves, for conveyance of the gasoline and for inflation of the landing floating devices. The gasoline supply is so arranged as to be easy, of certain action and reading controllable at any moment.

Screw Propellers with Adjustable Reversible Pitch

The first "F" dirigibles had fixed blade propellers with

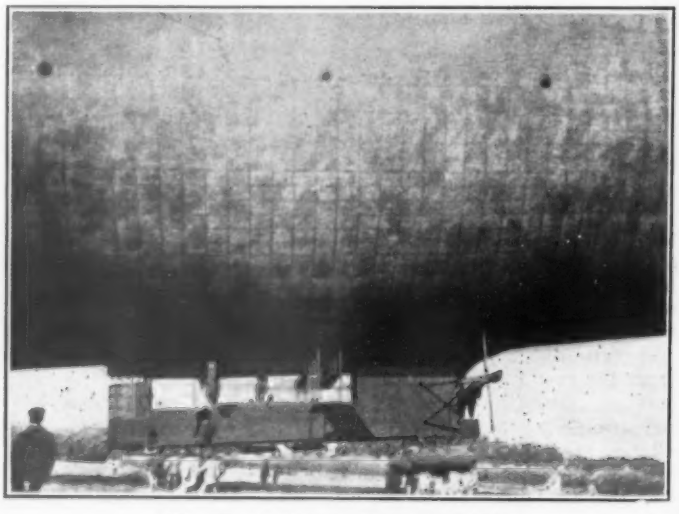


FIG. 7 A LATER TYPE, THE F4

large diameter and large pitch to suit. These propellers showed a very high efficiency but required a reversing gear for the maneuvers near the ground; they also required shafts revolving at low speeds and very heavy. In order to comply with the practical maneuvering requirements and reduce the air ship's weight, metal propellers with adjustable reversible

pitch have been adopted in the latest types, like the propellers of the Army dirigibles M, F and V.

In the dirigibles F.5 the pitch of either propeller is adjusted separately, owing to which the propellers can be used in addition to or in substiution for the vertical rudders for maneuvering near the ground.

Upper Platform with Shaft and Ladder Communication with the Car

The invariability of the dimensions of the "F" dirigibles enables a most convenient arrangement of the upper platform and the vertical shaft and ladder connecting the platform with the car. The ready accessibility of the upper platform is considered by all experienced men a *sine qua non* of an airship's military efficiency.

The upper platform is carried on rigid ribs fixed to the two top meridian lines of the gas envelope which are held fast by longitudinal partitions. The ribs extend sufficiently to make

FIG. 8 INFLATING A DIRIGIBLE—THE GIRDER WORK IS CLEARLY SEEN

the platform (even when the actual volume of the gas compartment reaches its lowest limit as steady as if it rested on a rigid framework.

This circumstance facilitates the installation of the vertical shaft (or pit) with a ladder inside.

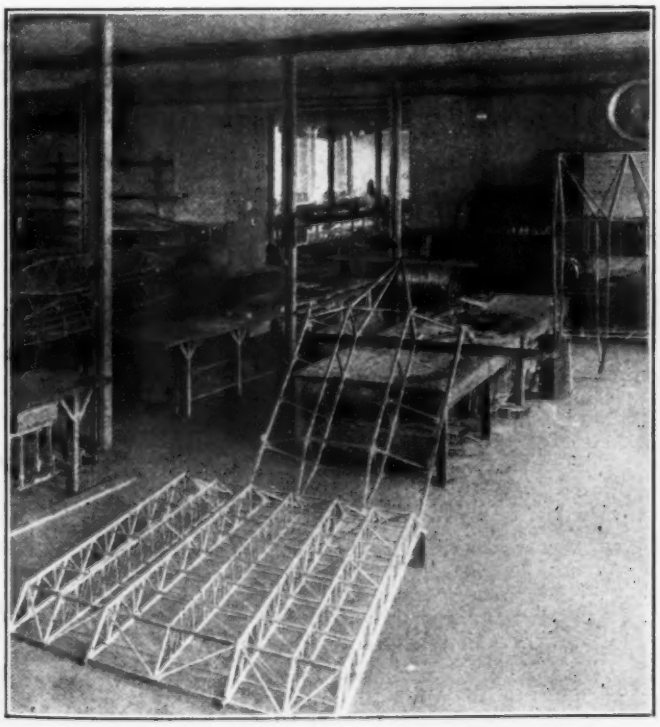


FIG. 9 CONTROL PLANES IN PROCESS OF CONSTRUCTION

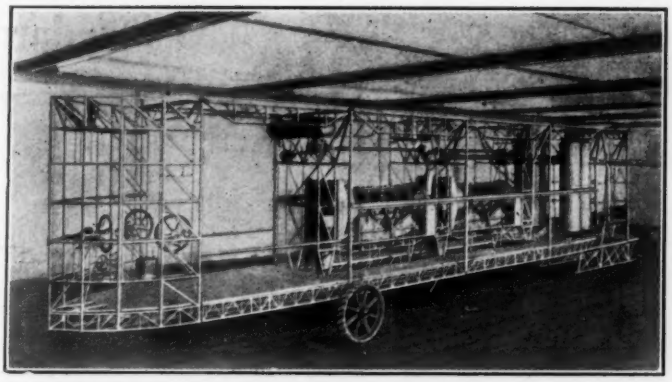


FIG. 10 THE CAR, READY FOR TRANSPORTATION INTO THE HANGAR

General Remarks

The figures in the annexed table clearly show the progress that has been made by the Societa' Leonardo Da Vinci in their successive constructions and bear out the high qualities of their more recent airships, viz.: the F.4, whose characteristic advantages have been demonstrated by actual practice, and of F.5 which is now in process of construction.

The following points are noteworthy:

(1) Even with average volumes and consequently moderate sizes it is possible to attain such relative lightness as will ensure that the highest altitudes will be reached.

(2) High speeds can be attained, at least at the high altitudes that are usual for military purposes.

(3) The total head resistance is very low.

(4) The compact construction of these dirigibles allows steep inclinations of their axis to the horizontal, and rapid ascending and descending speeds. Thus assuming that, in addition to the fuel and lubricating oil, 10 per cent of the fuel weight should be allowed for such supplies as water, victuals, etc., and assuming another 700 kilos weight for the crew and reserve ballast, the F.5 dirigible would be capable of starting from its base without making use of its dynamic ascending power, could rise at once up to 3500 m. and reach a desired object 800 km. away at the rate of 68 km. an hour, stand over its target at an altitude of 4000 m., throw 1600 kilos weight of bombs and return to its base, always keeping at altitudes over 5000 m. Attention is called to the fact that to travel at the average speed of 68 km. per hour at an altitude of 4000 m. the airship requires only 185 h.p. out of the 480 h.p. which can be developed from its two engines.

(5) Velocities of 110 km. an hour could be realized at high altitudes by increasing the volume to about 30,000 cubic meters, that is to say with a "F.7" type, the characteristic of which would be such as stated in the last column in the appended table.

	F. 1	F. 2	F. 3	F. 4	F. 5	F. 6	F. 7
Equator diameter.....m.	14	18	18	18	20	20	23
Length between perpendiculars.....m.	40	72	90	90	90	90	110
Total capacity.....cb.m.	3,700	13,000	15,000	15,000	19,000	19,000	30,000
Gas chamber capacity.cb.m.	3,265	11,800	13,800	13,900	17,800	17,800	28,000
Number of tight compartments.....	1	12	12	12	12	12	12
Total weight per cubic meter of gas.....Kg.	0.257	0.712	0.762	0.668	0.544	0.578	0.544
Total weight (exclusive of crew, armament and provision).....Kg.	2,800	8,400	10,500	9,300	9,700	10,300	15,200
Total weight that can be carried at 4,000 m. altitude.....Kg.	....	....	....	1,400	3,500	2,900	5,500
Maximum height attainable (with the help of aerodynamic power and with an ordinary crew and provisions for raid of 300 km).....m.	....	....	3,100	4,500	6,500	6,000	6,500
Average ballast-discharge per meter for rising about 4,000 m. high.....Kg.	....	....	....	0.950	1.220	1.220	1.920
Engines.....	1	2	4	2	2	4	4
Total power of engines (as measured on the ground).....H.P.	40	170	400	320	480	760	1400
Maximum power which the engines are actually called upon to develop wher travelling.....H.P.	30	160	360	300	300	425	800
Maximum speed near the ground.....Km. per hour	50	63	74.5	73	70	75	80
Maximum speed at 2,000 m.....Km. per hour	....	62.5	74	80	75	81	90
Maximum speed at 4,000 m.....Km. per hour	....	....	....	78	80	90	97
Maximum speed at 5,000 m.....Km. per hour	....	....	....	78	79	95	104
Maximum speed at 6,000 m.....Km. per hour	....	....	....	....	78	100	110
Fuel and lubricating oil consumption at cruising speed (0.85 maximum) and at the indicated altitudes, per hr.	....	....	Kg. 42 m.2,500	35 4,000	45 4,000	65 4,000	125 4,000
Ditto.....per Km	0.100	0.355	0.660	0.575	0.665	0.85	1.47
Rising and descending speed 1,000 m. in.....	....	....	6′	5′ 5″	6′	6′	6′

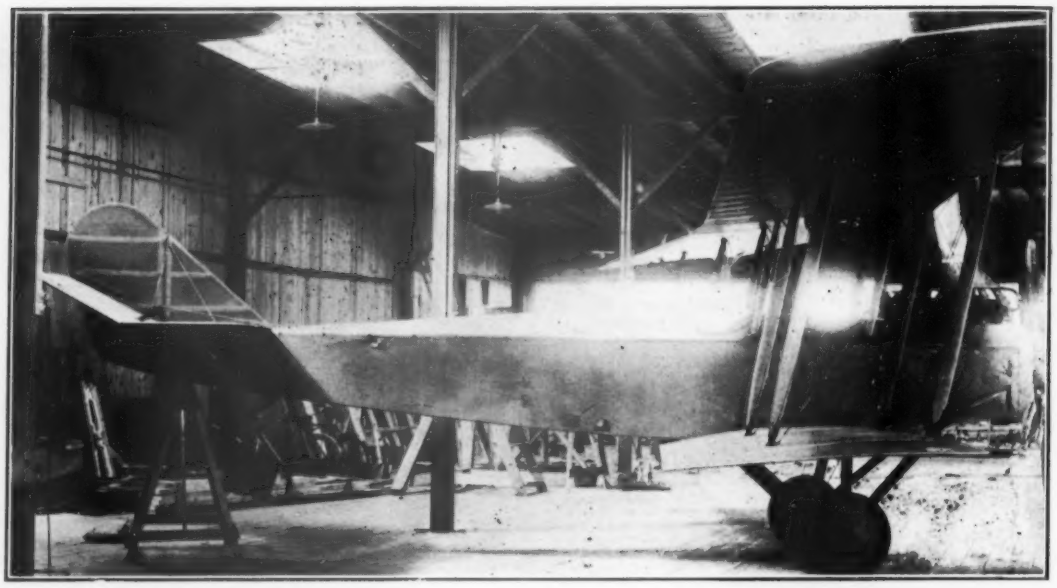
The Standard Model "J-R"

The Standard Aero Corporation has recently produced an interesting development of their primary training model "J."

The 90hp. Hall-Scott has been replaced by the A-7a six-cylinder engine of the same company. Very high compression enables this engine to deliver 175 horsepower.

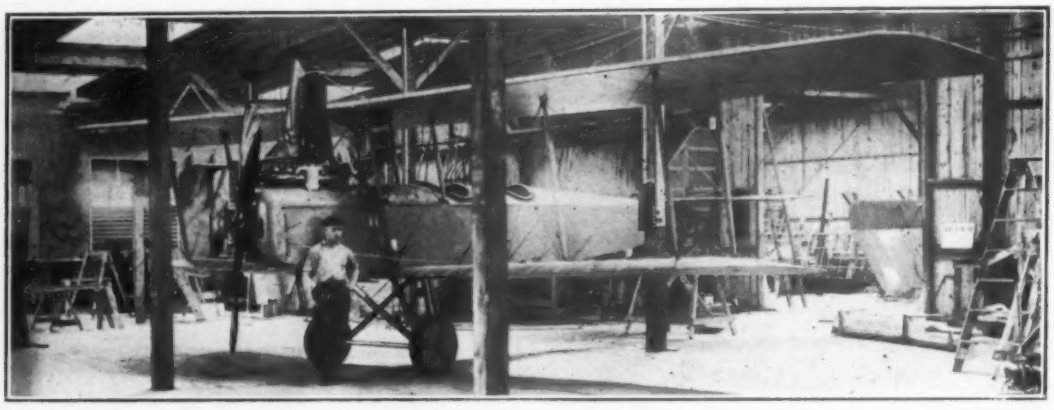
Instead of the R.A.F. 3, the U.S.A. 6 is now employed. The use of a better wing section and the higher power have transformed a slow school machine into a very fast reconnaissance type.

Three views of the machine are shown herewith, together with three interesting photographs.



SIDE VIEW OF THE STANDARD J-R PURSUIT MACHINE, SHOWING NEW EXHAUST MANIFOLD. NOTE THE PRONOUNCED STAGGER

The new stream line exhaust header carries the exhaust well over the upper surfaces. The landing gear is streamlined throughout. The axle rises in vertical guides, and when normal rests in a U-shaped steel case streamlined with aluminum.



THREE-QUARTERS FRONT VIEW OF THE STANDARD J-R, SHOWING NEW EXHAUST LEADER, WHICH CARRIES EXHAUST OVER THE TOP WING

All wing struts are provided with ball and socket fittings.

The engine bed is made very rigid by means of steel tube stays which connect the ash engine supports to the longerons.

There is a single control of the Dep. type in the rear cockpit.

The general specifications given by the Standard are as follows:

Dimensions, Specifications and Performance of the Model J-R

General Dimensions

Wing span, upper plane	42′ 10″
Wing span, lower plane	31′
Wing chord	6′
Gap between wings	71″
Stagger	10°
Overall length of machine	27′ 2½″
Overall height of machine	10′ 10″
Angle of incidence	2½°
Dihedral angle	3°
Sweepback	5°
Wing curve	U. S. A. No. 6
Horizontal stabilizer, angle of incidence	0°

Areas

Upper wing	258 sq. ft.
Lower wing	159 " "
Total supporting surface (wings and ailerons)	417 " "
Ailerons (each 21 sq. ft.)	42 " "
Stabilizer—horizontal	23.7 sq. ft.
Stabilizer—vertical	3.7 " "
Elevators (each 11 sq. ft.)	22 sq. ft.
Rudder	10 " "
Maximum load per sq. ft. supporting surface	5.75 lbs.
Maximum load per H.P.	13.7 "

Weight

Net weight—machine empty	1764 lbs.
Gross weight—machine loaded	2400 "

Performance

Maximum speed—full load	95 M. P. H.
Minimum speed—full load	48 "
Gliding angle	1 to 11
Climbing speed in 10 minutes	5000 feet

Power Plant

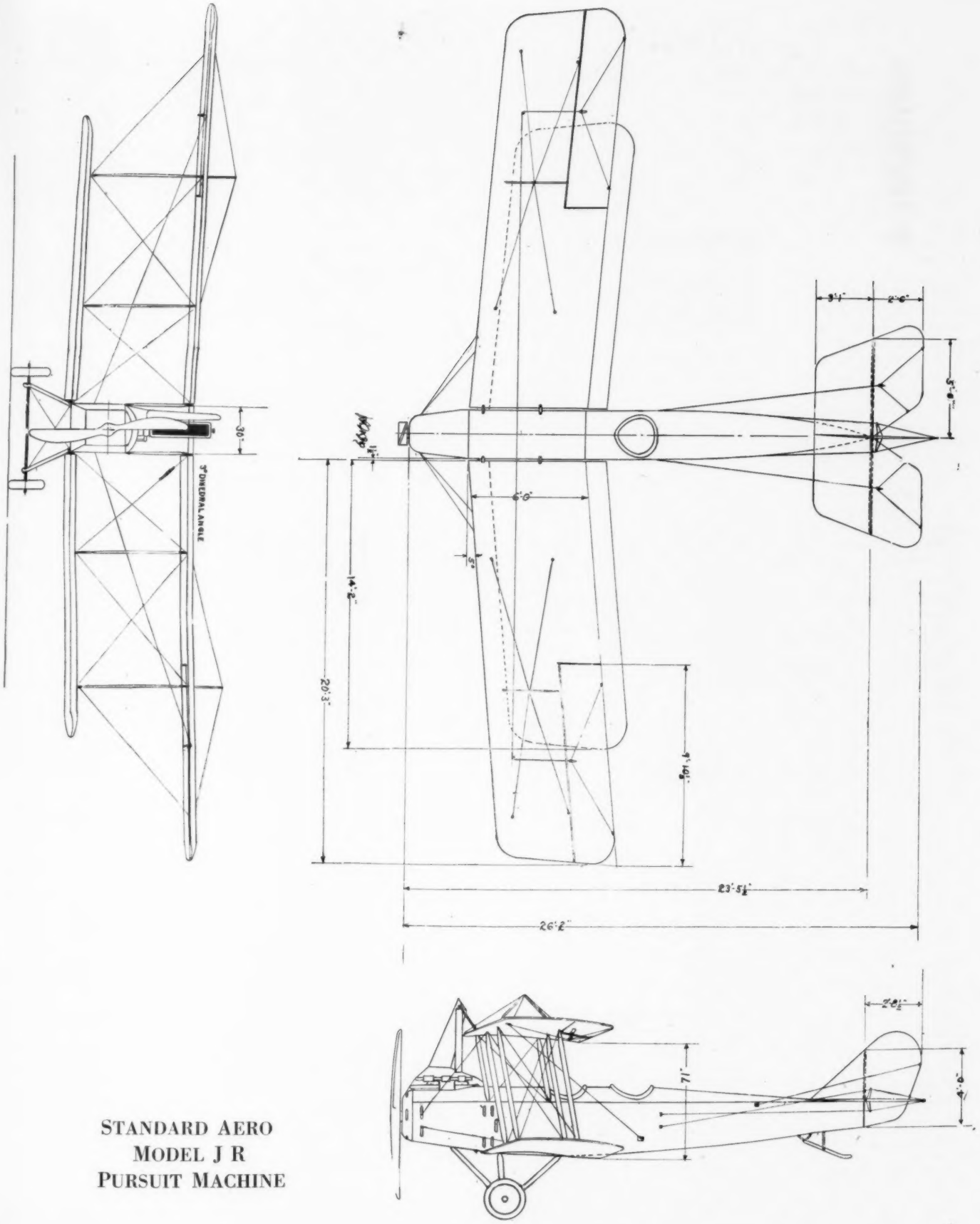
Hall-Scott A-7A special, 6 cyl. vert. four stroke cyle. water cooled	
Horse-power (rated at 1400 R.P.M.)	175 H.P.
Weight	605 lbs.
Bore and stroke	5¼″ x 7″
Fuel consumption per hour	14 gals.
Fuel tank capacity	51 "
Gravity tank capacity	7¾ "
Total tank capacity	58¾ "
Oil capacity in crank case	4 "

Propeller

Make	"Standard"
Material	Black walnut.
Diameter	8′ 4″
Pitch	5′ 6″
Direction of rotation (viewed from pilot's seat)	Clockwise

Landing Gear

Number of wheels	2
Size of wheels	26″ x 4″



STANDARD AERO
MODEL J R
PURSUIT MACHINE

Extracts from Inspectors' Manual Aviation Section, Signal Corps, U. S. A.

(Continued from the issue of July 15.)

Inspection of Linen

All linen used in airplane construction should be up to the following specifications:

Free from all knots or kinks.
Without sizing or filling.
As near white as possible.
Weight, between 3.5 and 4.5 ounces per square yard.
Strength per inch should comply with Signal Corps specifications.

Inspection of Propellers

Army inspectors should inspect all wood to be used in propellers for Government use. This wood should be well seasoned; free from knots, sap pockets, dry rot, and should be straight in grain.

Laminations should extend the entire length of the propeller of the two-bladed type and no splices should be allowed in laminations in the hub. On three-bladed type the splices should be made so as to get greatest glue surface and greatest cross section of wood.

Metal tipping should be inspected to see that the metal lies close to wood, that nails or rivets have not split the blade, and that solder is placed smoothly and properly.

Propeller hubs should be pressed into propellers on an arbor press, and great care should be taken that the wood is not injured in the process but that a tight fit is secured. Hub bolts should fit hub flanges with very small clearance but without filling, and should be a light drive fit through wood. The taper and keyway or splines should be carefuly inspected and no nickel plating should be allowed in these surfaces. Hub bolts should be wired in an approved manner.

Before shipping from factory, all propellers should be checked for balance (standing) on true knife edges, for cheeks in wood, for cracks in glue joints, and for alinement of blades. This final inspection should be made immediately before shipping.

Propellers should be checked for pitch as per sketches or in some other approved manner.

The maximum allowable variation in checking blades of the same propellers is as follows:

	Maximum variation, in inches.
For 8-feet diameter	0.24
For 8 feet 6 inches diameter	.25
For 9-feet diameter	.27
For 9 feet 3 inches diameter	.28
For 9 feet 6 inches diameter	.29
Alinement (to be measured at a point about 2 inches from tip):	
For 8-feet diameter	.125
For 8 feet 6 inches diameter	.166
For 9-feet diameter	.200
For 9 feet 3 inches diameter	.225
For 9 feet 6 inches diameter	.250
Pitch (taken at points 62½ per cent, 75 per cent, and 87½ per cent from hub):	
For 5 feet 5 inches pitch	1.00
For 5 feet 6 inches pitch	1.02
For 5 feet 11 inches pitch	1.10

Inspection of Radiators

Radiators should receive the following test:

Each radiator is to be submerged in water and tested with an air pressure of 6 pounds, and when passed must be free from all leaks. In inspecting radiators, care should be taken that provision is made to install in such a way that the radiators will not be injured by vibration.

Inspection of Wood

All wood should be inspected before varnish is applied. The following questions should receive the inspector's approval before he passes any wood for Government use:

Is grain satisfactory?
Are there any sap or worm holes?
Are there any knots that look as if they would weaken member?
Any brashiness?
Any holes drilled for bolts or screws that would weaken member?
Any splits or checks?
Are laminations glued properly?
Are there any plugged holes?
Any signs of dry-rot?

Inspection of Metal Fittings

When fittings are copper plated and japanned, the inspection should take place after the copper plating. The following questions should be approved by the inspector before being passed:

Have fittings been bent in assembly?
Does fitting show any defects that lessen its strength?
Are holes drilled properly?
Do fittings fit?

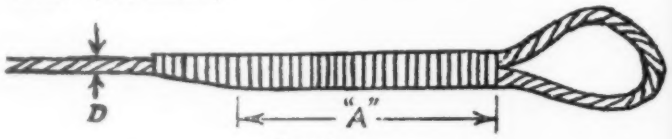
Inspection of Sheet Aluminum

Sheet aluminum should be inspected for defects such as cracks, bad dents, and under specifications in gauge. Where openings occur in sheet aluminum the corners should be rounded, allowing a good-sized radius.

Correct Winding for Different Sized Cables

Windings must be even, with a nice stream-line effect at end of winding. When solder is used, care should be taken that acid does not go beyond soldered portion of cable.

Dimensions "A" to be at least 15 times D or diameter of cable. (See sketch.)



Size of cable. *Inch.*	Length of winding. *Inches.*	Breaking strength. *Pounds.*
1-32	1½	185
1-16	1½	500
3-32	1½	1,100
7-64	1¾	1,600
⅛	2	2,100
5-32	2⅜	3,200
3-16	3	*5,500
7-32	3⅜	6,100
¼	3¾	8,000
5-16	4¾	12,500

*5,500 pounds for cable, but only 5,100 pounds for loop.

Only nonacid flux should be used in soldering.

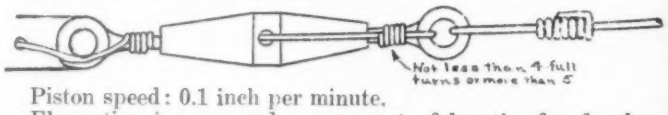
Approved Method of Wiring Turnbuckle

Inspectors will examine all turnbuckles in every assembled machine to ascertain that these parts are locked in a manner complying with the best practice. When wire is used to lock the turnbuckle, it should be of 20 ga. hard copper wire and secured in an approved manner. Wiring in the manner shown below has proved most satisfactory.

Notes on Turnbuckles and Connections

Standard test for turnbuckles: rods are screwed into barrel full length of threads on rods, so that last thread is flush with end of barrel, unless otherwise stated.

Turnbuckles held by pin connections.

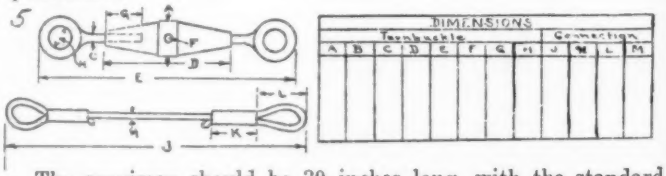


Piston speed: 0.1 inch per minute.

Elongation is measured as per cent of length of rod, when break occurs in rod, and per cent of total length of barrel when break occurs in barrel.

Standard Dimensions and Letters for Turnbuckles

Inspectors submitting wire or cable test specimens to this office for test by the Bureau of Standards should follow this procedure:



The specimen should be 30 inches long, with the standard connections used in service by the manufacturer attached to both ends.

Testing of Ignition Systems

Before Mounting on Engine

It is advisable to test the ignition system before it is

mounted on the engine, as this may save considerable work later in tracing troubles.

I. Magnetos

1. Mount magneto on a stand. This should consist of a metal plate with means of fastening the magneto; the test stand must consist of nonmagnetic metal, such as aluminum or brass, and be connected to a grounded water or gas pipe in order to avoid static discharges.

2. Provide magneto with a pulley for driving; pulley with two or three steps of different radii, and with a belt groove on each step for driving at different speeds, is preferable.

3. Provide necessary amount of test spark gaps, one for each high tension terminal on the magneto, see sketch. Clean test spark gaps with alcohol in order to remove all moisture and prevent surface leakage of high tension current. Adjust test spark gaps as per sketch, distance from (2) to (3) should be so as to allow a thin piece of paper to be slipped in between the points, without the paper being torn, but the paper should touch both points at the same time. Distance between (1) and (2) should be 5 mm.; connect (2) to high-tension terminal on magneto and (1) to the grounded test stand.

4. Use standard high-tension cables for making connections; all contacts must be good and all connections tight.

Adjustments of Magneto

5. If possible, remove cap on breaker box, so that operation of breaker points can be observed during test. Adjust the distance between the breaker points before the test; the distance should be as follows:

Dixie magnetos, 0.45-0.55 mm., or 0.018-0.022 inch.
Berling magnetos, 0.40-0.50 mm., or 0.016-0.020 inch.
Bosch magnetos, 0.35-0.45 mm., or 0.014-0.018 inch.
Berkshire magnetos.
K. W. magnetos.

Breaker points must be clean, make contact over the whole surface, and line up properly; no pitting, burning, or oxidizing must have taken place.

Test

6. Allow magneto to run for 10 minutes in order to be run in before starting the test; the speed of the magneto during the test should be 15 per cent over the rated magneto speed. Rated magneto speed means the speed at which the magneto is running when the engine is running at its full rated speed. The magneto should be tested for three hours at above speed.

If it is found necessary to change magnetos after the engine has made the six hours' run, the new magneto should be given a six hours' run on the test bench at 15 per cent over rated speed. After this, the magneto is mounted on the engine. The engine should then be tested for one hour on dynamometer to check up the power at full rated speed.

7. Observe closely the sparks; all sparks should be of the same size—i.e., the corona or the flame on the sparks should be of the same size and be even, not show periodical increasing or decreasing. It is necessary to watch a spark closely for two to three minutes in order to detect any missing. No missing must appear at above speed.

8. Watch closely the performance of the breaker points. No arcing between the points must take place. Listen for excessive noise from the ball bearings; excessive noise indicates that the bearings are not properly adjusted, and this may cause breakdown in short time.

9. For the slow speed, run the magneto at approximately 50 r.p.m., and increase the speed slowly until the sparks appear absolutely regular without missing. This should be done with the magneto in full advance, as well as in full retard position. Note these speeds: It should not exceed 100 to 150 r.p.m. for full advance, and 200 to 275 for full retard position, as the starting of the engine otherwise will be too difficult. The variation of the magneto speed can be made by using a friction disk arrangement, or if an eleetrometer is used by changing the resistance in the field and in the armature.

Inspection of Magneto After Test

10. After the test is finished the magneto should be inspected and the following points noted:

The breaker points must still be in good condition; no burning must have taken place.

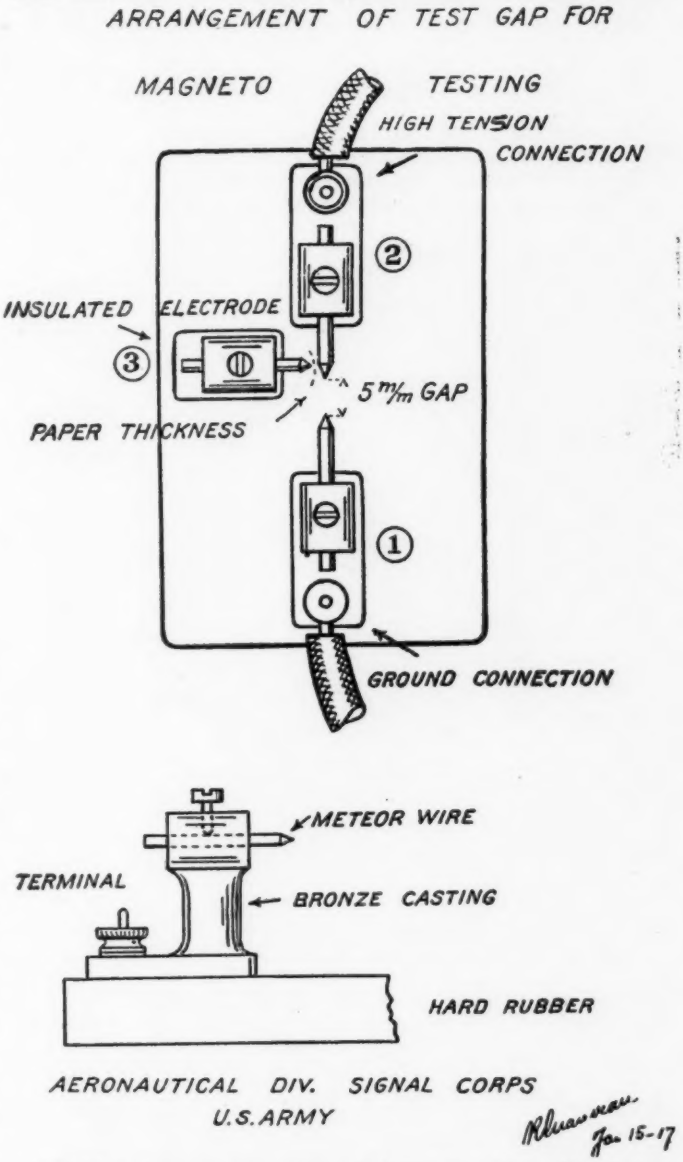
Remove the distributor plate and see if carbons show any excessive wear. The wearing surface should show a high polish, and no carbon dust should be seen inside the distributor plate.

The segments inside the distributor plate must not show any burning of the edges, and the entire surface should show a good polish. Segments must not extend beyond the surface of the insulation composition.

Reassemble the magneto, and it is then ready to be mounted on the engine.

II. Battery System

11. Mount the timer distributor similar to the magneto. This requires special fixtures, which do not necessarily have to be of non-magnetic material. Provide a pulley for driving the timer distributor in a similar way as for magneto under No. 2.



12. Make proper connections between the timer distributor, high-tension coil, and storage battery, as indicated on manufacturer's diagram, and make high-tension connection to test spark gaps as for magneto under No. 3. Do not make final connection between the high-tension coil and the storage battery until immediately after the timer distributor is started to run, as the excessive current which passes through the coil when the timer is standing still will injure the coil if it is allowed to flow for any longer period. Connect an amperemeter with scale reading 0-25 amperes in between the storage battery and the coil, and report the current consumption when the timer distributor is running at rated speed.

13. Use a storage battery of not less than 50 ampere-hours, and ascertain before test that the battery is 75 per cent charged—i. e., reading with hydrometer should show not less than 1,200 "points"; connection to storage battery must be clean.

14. Make all adjustments as described for magneto under

No. 3, No. 4, and No. 5, and make test as described for magneto under No. 6, No. 7, and No. 8.

15. Inspect the timer distributor as under No. 9.

After Mounting on Engine

I. Magnetos

16. Check the point of firing. This depends on the type of engine, compression, and ignition system used; battery ignition calls for a larger degree of advance than does magnetic ignition; the proper point of setting is decided by the manufacturer of the engine. The point of firing can be measured on the piston stroke in inches, but it is preferable to measure it in degrees on a graduated dial, if such can be placed on the crank shaft or on the propeller hub.

17. If two independent ignition systems are used, the difference in firing point between these should not exceed 2 to 3 degrees. This should be checked up in the same way as above.

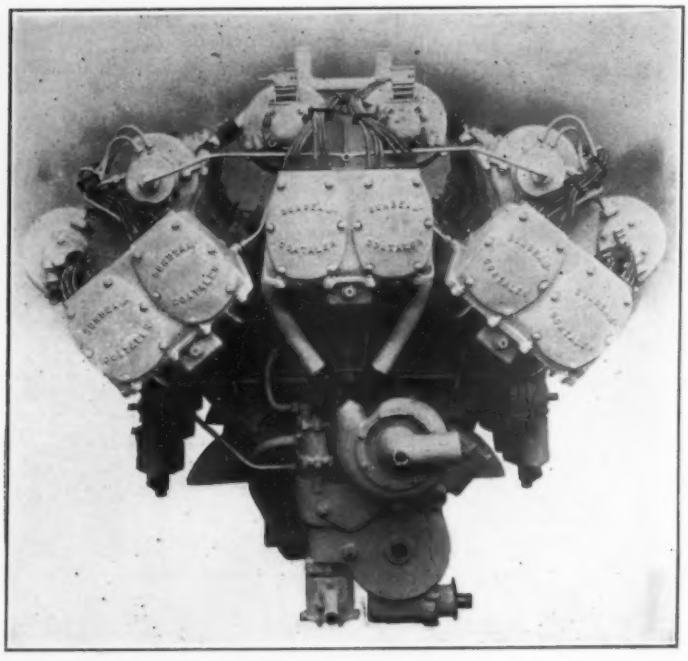
Wiring Cables

18. See that all terminals are in good condition, give good contact, and that all terminals are tight and secured. Check up all wiring. High-tension cables must be held in tubing of insulation material or strung free in the air, held at intervals by supports of fiber or bakelite, but should not be inclosed in metal tubing. High-tension cables should not come in contact with any grounded metal, as this in time may cause breakdown. High-tension cables should be held in such a way that no movement of the cables can take place, as this may result in chafing of the cable insulation.

(To be continued)

The New Sunbeam Overhead Valve Type Engines

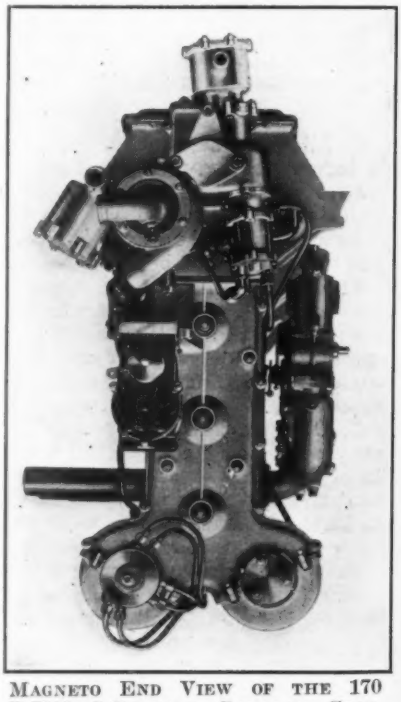
The censorship has now passed for publication a few views of some of the latest Sunbeam-Coatalen aircraft engine types. These are interesting alike for the points they possess, which may be of service to aircraft engine production in the future,



MAGNETO END VIEW OF THE 475 B.H.P. 18-CYLINDER SUNBEAM-COATALEN ENGINE OF THE BROAD ARROW TYPE

and for the features in which they must always differ from that which is suitable for car practice.

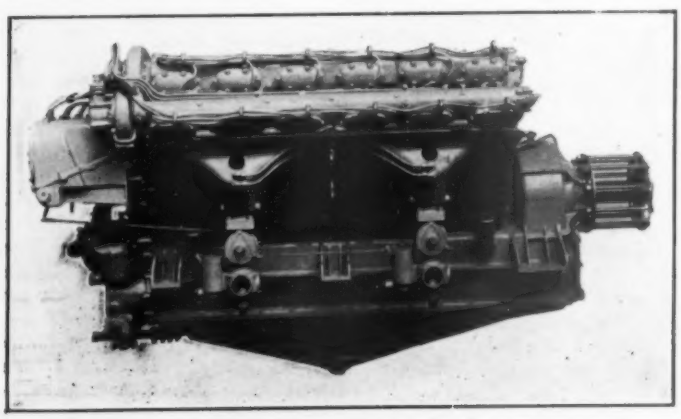
In regard to all the types of engines illustrated, it will be observed that the crankcase and nose piece are cast in one, whereby there is achieved the dual gain of lightness and proportionately greater rigidity, to say nothing of accessibility and so forth. In these features such engines must always differ from motor car practice. Another point concerns the absence of flywheels. The engine base, on the other hand, which is a dry sump in combination with a compound pump at the bottom, represents a scheme which may become a feature of standardized motor car engine practice at some future period. Every example of this series of Sunbeam-Coatalen aircraft engines has overhead valves on the principle of two inlet and two exhaust valves per cylinder, with the sparking plug set in practically the ideal position. The series of views illustrates the vertical, narrow type of engine; the V-form; and the broad arrow type wherein three rows, each of six cylinders, are set on a common crankcase. In this water-cooled series the gasoline and oil consumption is notably low, as is the weight per horsepower, particularly in face of the handicap under which British manufacturers have to work nowadays owing to the relative unreliability of magnetos.



MAGNETO END VIEW OF THE 170 B.H.P. 6-CYLINDER SUNBEAM COATALEN ENGINE

Thus in regard to the 18-cylinder overhead valve Sunbeam-Coatalen aircraft engine of 475 brake-horsepower, there are no fewer than half a dozen magnetos. Each magneto is enclosed. Two sparks are furnished to each cylinder from independent magnetos. On this engine there are also no fewer than six carbureters. Shortness of crankshaft, therefore of engine length, and absence of vibration are achieved by the linking of the connecting rods. Those concerned with three cylinders in the broad arrow formation work on one crankpin, the outer rods being linked to the central, master one. In consequence of this arrangement, the piston travel in the case of the central row of cylinders is 160 mm., while the stroke of the pistons of the cylinders set on either side is in each case 168 mm.

The duplicate ignition scheme also applies to the 12-cylinder, 350 brake-horsepower Sunbeam-Coatalen overhead valve aircraft engine type. It is distinguishable, incidentally, by the passage formed through the center of each induction pipe for the sparking plug in the center cylinder of each block of three. In this, as in the 18-cylinder and the 6-cylinder types, there are two camshafts for each set of cylinders. These camshafts are lubricated by low pressure and are operated through a train of enclosed spur wheels situated at the magneto end.



SIDE VIEW OF THE 350 B.H.P. 12-CYLINDER SUNBEAM-COATALEN ENGINE

Course in Aerodynamics and Airplane Design

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and

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PART II—SECTION 12

Wing Structure Analysis for Biplanes

Reactions in Plane of Lift Truss Due to Upper Rear Spar at 0 Deg.

At the conclusion of the previous section, we drew the bending moment diagram for the upper rear spar as a continuous beam, and found the appropriate reactions. But since the bending moment diagram was drawn for that component of the force in the plane of the lift truss which was in the plane of the spar web, allowance has to be made for it on reverting to the lift truss. The running loads were in the ratio of 14 to 13.8. Hence reactions are

$$R_2 \quad 83.1 \times \frac{14}{13.8} = 84.8 \text{ lb.}$$

$$R_0 \quad 116.5 \times \frac{14}{13.8} = 118.0 \text{ lb.}$$

$$R_1 \quad 34.6 \times \frac{14}{13.8} = 35.1 \text{ lb.}$$

Reactions in Plane of Lift Truss Due to Lower Rear Spar at 0 Deg.

Since the spacing of the supporting points on the lower wing is identical with that of the upper wing, and the slight overhang is the same, the bending moment diagram and the shears and reactions will be in direct ratio to the loads. The ratio of loads on upper plane to lower plane is 14 to 11.5. Hence reactions are

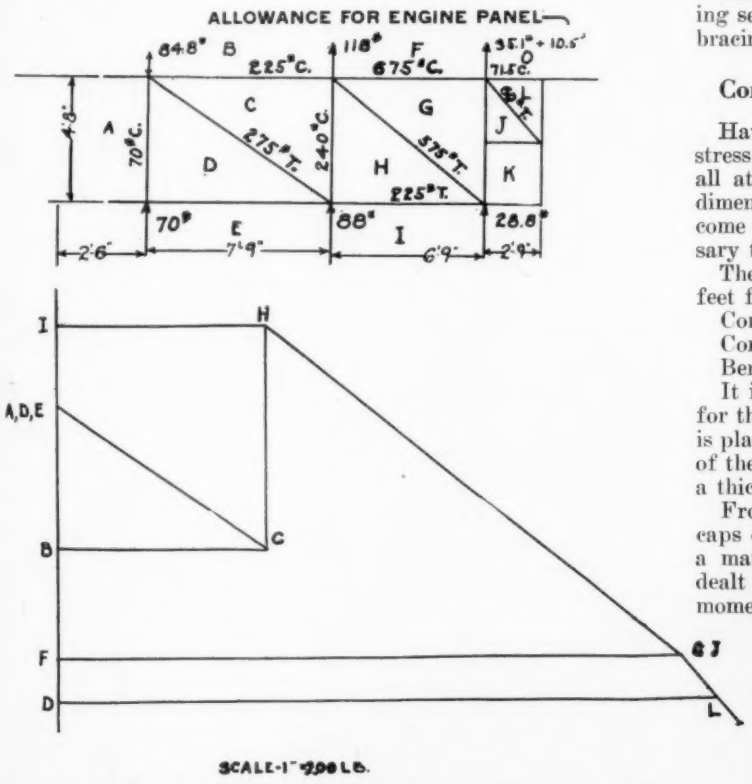


FIG. 1 STRESS DIAGRAM OF REAR LIFT TRUSS AT 0 DEG. INCIDENCE

$$R_2 \quad 84.8 \times \frac{11.5}{14.0} = 70 \text{ lb.}$$

$$R_0 \quad 118 \times \frac{11.5}{14.0} = 88 \text{ lb.}$$

$$R_1 \quad 35.1 \times \frac{11.5}{14.0} = 28.8 \text{ lb.}$$

Stress Diagram for Rear Lift Truss at 0 Deg.

We are now in a position to draw the stress diagram for the lift truss as shown in Fig. 1. The only other load to be added is 10.5 lb., which is allowance for half the air force due to the engine panel acting on the rear spar.

In drawing this stress diagram, the strut G J is assumed as taking no tensile load, and the lift load at O F is transmitted by the cross wire L J to the body.

Stress Diagram for Internal Upper Wing Bracing at 0 Deg.

In Fig. 2 is drawn the stress diagram for the internal bracing of the upper wing at 0 deg. incidence.

The spars have so much less resisting moment in the plane of the wing that it is perfectly justifiable to treat the interplane wing bracing as a pin-jointed structure and neglect all consideration of bending moments.

The running loads per foot run are taken from the preceding sections, with the addition of ½ lb. drift at each external bracing point.

Computations for Dimensions of Rear Upper Spar

Having drawn the bending moment diagram, the lift truss stress diagram and the internal wing bracing stress diagram, all at 0 deg. incidence, we are in position to determine the dimensions of the rear upper spar. Since the worst loads come on the rear spar at this angle of incidence, it is not necessary to recompute it at 16 deg. also.

The worst loads it has to meet occur in the inner span, 3 feet from the wing hinge:

Compression from the lift diagram of 675 lb.

Compression from the drag diagram of 330 lb.

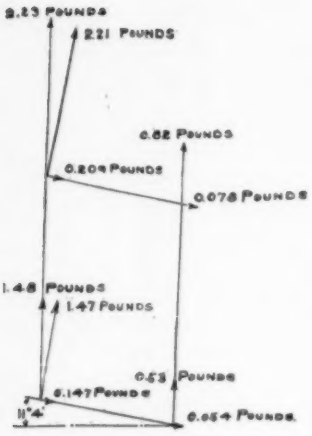
Bending moment of 44 ft. lb.

It is first of all necessary to fix the effective depth of spar for the wing section employed, namely, the R.A.F.6. The spar is placed at 30 per cent from the rear edge, where the thickness of the wing is .054 of the chord. For a 62-in. chord, this gives a thickness of 3.34 in., or 3 21/64 in. very nearly.

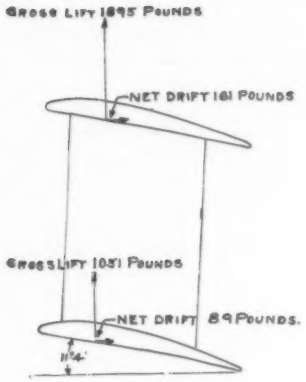
From this must be deducted the thickness of the two rib caps or flanges. The construction and dimensioning of ribs is a matter of some uncertainty and controversy, and will be dealt with fully in a later article. We will assume for the moment that a thickness of ⅛ in. will be sufficient for the rib flanges, so that the effective depth of the flanges will be reduced to 3 5/64 in. The actual drawing up of the beams is largely a matter of trial and error. That is to say, an apparently suitable section has to be drawn in its area, and moments of inertia, etc., have to be computed together with the factor of safety consequent thereon.

After a number of trials, the spar section of Fig. 3 is found to be satisfactory.

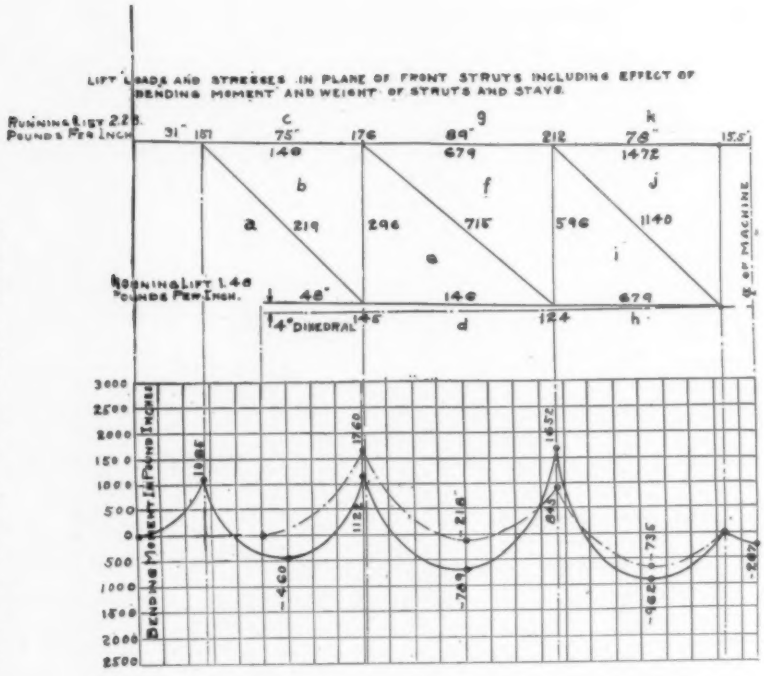
ANALYSIS FOR LOW SPEEDS, 50 M.P.H.



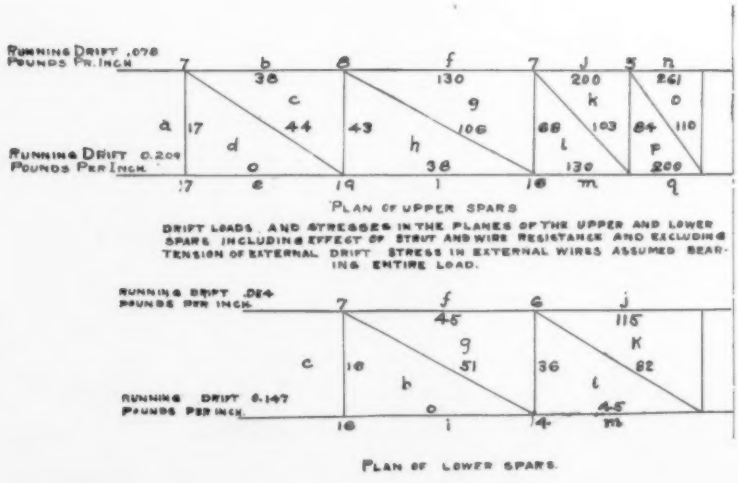
NET RUNNING LIFT AND DRIFT COMPONENTS
4 PLANES OF WING TRUSSING



GROSS LIFT AND NET DRIFT
ON SUPPORTING PLANES


LIFT LOADS AND STRESSES IN PLANE OF FRONT STRUTS INCLUDING EFFECT OF BENDING MOMENT AND WEIGHT OF STRUTS AND STAYS.
RUNNING LIFT 2.23 POUNDS PER INCH
RUNNING LIFT 1.48 POUNDS PER INCH
4° DIHEDRAL
BENDING MOMENT IN POUND INCHES

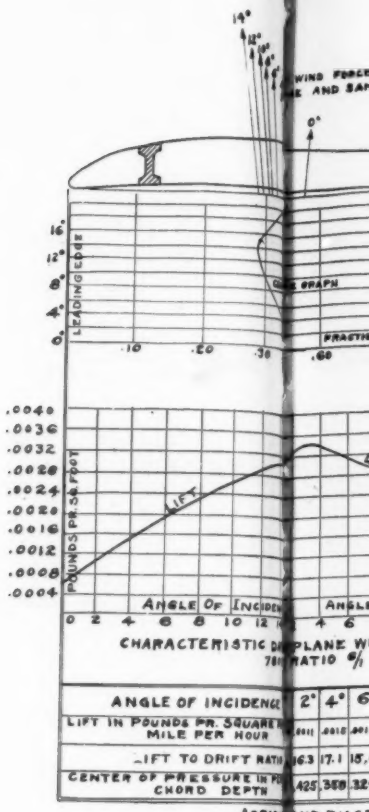
BENDING MOMENTS ON FRONT, TOP AND LOWER SPARS
IN PLANE OF I BEAM WEB.


RUNNING DRIFT .078 POUNDS PER INCH
RUNNING DRIFT 0.209 POUNDS PER INCH
RUNNING DRIFT .084 POUNDS PER INCH
RUNNING DRIFT 0.147 POUNDS PER INCH

PLAN OF UPPER SPARS

DRIFT LOADS AND STRESSES IN THE PLANES OF THE UPPER AND LOWER SPARS INCLUDING EFFECT OF STRUT AND WIRE RESISTANCE AND EXCLUDING TENSION OF EXTERNAL DRIFT. STRESS IN EXTERNAL WIRES ASSUMED BEARING ENTIRE LOAD.

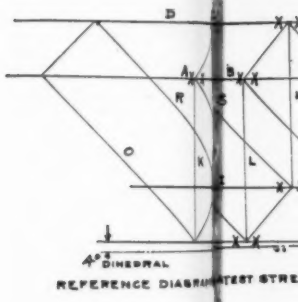
PLAN OF LOWER SPARS.



CHARACTERISTIC OF PLANE W... RATIO 6/1

ANGLE OF INCIDENCE	2°	4°	6
LIFT IN POUNDS PR. SQUARE MILE PER HOUR	.0011	.0018	.00
LIFT TO DRIFT RATIO	16.3	17.1	15.
CENTER OF PRESSURE IN F... CHORD DEPTH	.425	.389	.32

AERO... AND DIAG...



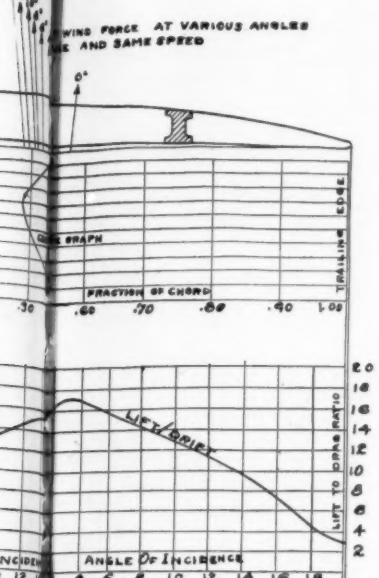
REFERENCE DIAGRA... TEST STRE...

SYMBOL	MEMBER	MATERIAL	SECTIONAL AREA SQUARE INCHES	MOMENT OF INERTIA	SECTION MODULUS	SPEED ... LBS./SQ.IN. DRIFT
A	FRONT SPAR	SPRUCE	4.0	8.1	3.8	0
B	"	"	"	"	"	+9
C	"	"	"	"	"	+50
D	REAR SPAR	"	4.73	5.48	3.54	-8
E	"	"	"	"	"	-28
F	"	"	"	"	"	-55
G	FRONT SPAR	"	4.0	8.1	3.8	+0
H	"	"	"	"	"	+11
I	REAR SPAR	"	4.73	5.48	3.54	-9
J	"	"	"	"	"	-24
K	LIFT STRUT		4.88	0.79		
L	"		7.88	2.07		
M	"		4.16	0.57		
N	"		6.5	1.39		
	LIFT CABLE	SOFT ROEBLING STEEL	NO. OF CABLES	DIA. OF CABLES	BREAKING LOAD	
O	"	"	2	5/32	6400	
P	"	"	2	"	"	
Q	"	"	2	7/32	11200	
R	"	"	2	5/32	6400	
S	"	"	2	"	"	
T	"	"	2	7/32	11200	

FACTORS OF SAFETY ARE 6 ... POINTS ...
FOR STRESS IN DRIFT WIRES ... TS SEE ...

ASSEMBLED DATA ... MPUTE ...

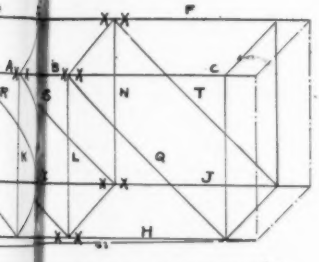
FIG. 4



PLANE WING SHAPE - AIR AT 15°CENT.
RATIO %

DENCE	2°	4°	6°	8°	10°	12°	14°	16°	18°
UARE FOOT	.0011	.0015	.0018	.0022	.0025	.0029	.0030	.0030	.0029
T RATIO	6.3	17.1	15.8	14.2	12.6	11.6	9.7	7.5	4.3
E IN PER PTH	.425	.368	.329	.312	.302	.292	.280	.296	.336

AERODYNAMIC AND DIAGRAMS

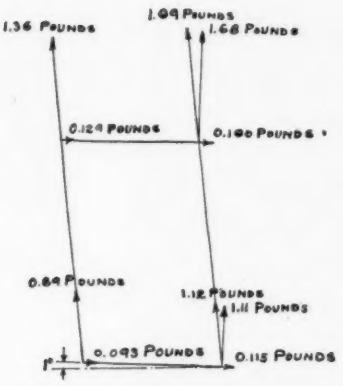


GREATEST STRESS MARKED THUS "X

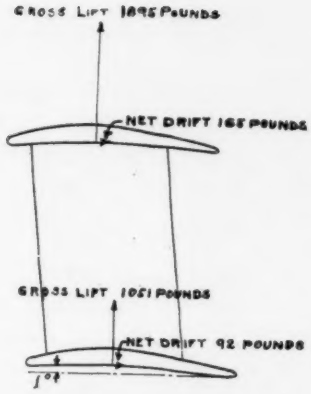
SPEED			FOR HIGH SPEED			
LBS./SQUARE FOOT	DRIFT	FACTOR OF SAFETY	FIBRE STRESS IN LBS./SQ. IN. BENDING	LIFT	DRIFT	FACTOR OF SAFETY
.8	0	20	±181	-22	0	33
"	+9	11	±266	-104	+13	19
"	+50	9	±266	-226	+70	16
54	-8	49	±241	-24	-10	24
"	-28	26	±356	-109	-38	13
"	-55	19	±356	-236	-80	10
8	+0	13	±273	+22	+0	23
"	+11	16	±149	+104	+15	25
54	-9	30	±365	+24	-13	18
"	-24	58	±182	+109	-36	26
		8		-181		14
		11		-364		18
		17		-224		8
		20		-452		10
		29		+134		47
		9		+436		14
		9		+696		16
		79		+166		38
		24		+542		11
		26		+865		13

POINTS OF GREATEST STRESS
TS SEE DRIFT DIAGRAMS.

AMPUTED VALUES

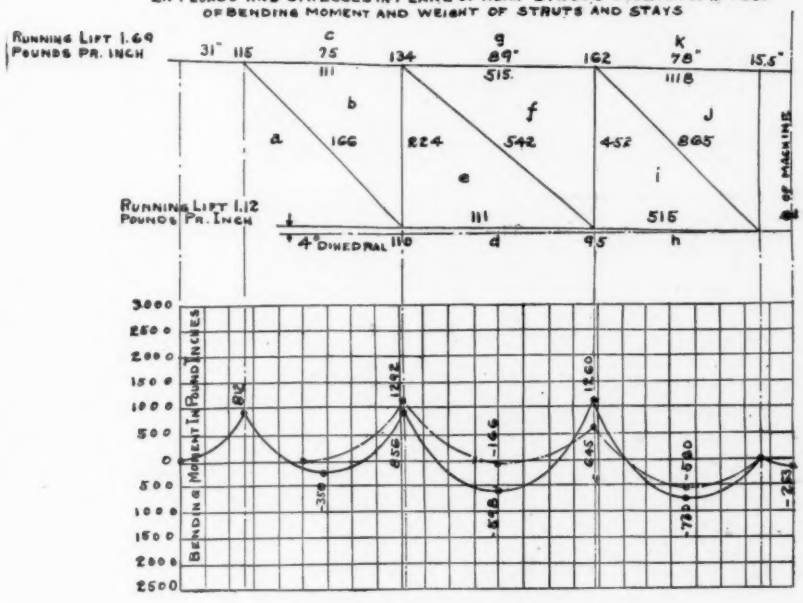


NET RUNNING LIFT AND DRIFT COMPONENTS IN PLANES OF WING TRUSSING

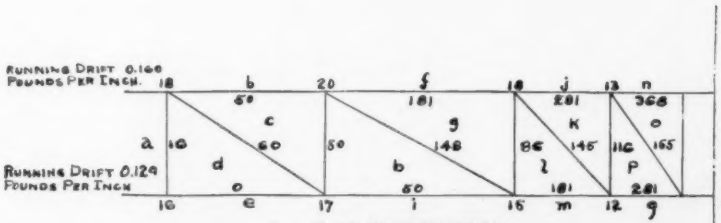


GROSS LIFT AND DRIFT ON SUPPORTING PLANES

LIFT LOADS AND STRESSES IN PLANE OF REAR STRUTS INCLUDING EFFECT OF BENDING MOMENT AND WEIGHT OF STRUTS AND STAYS

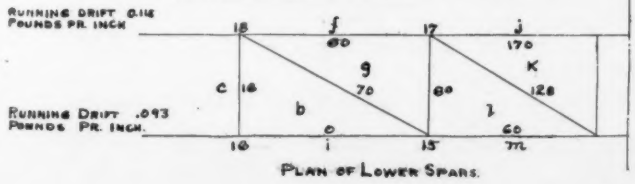


BENDING MOMENTS ON FRONT, TOP AND LOWER SPARS IN PLANES OF I BEAM WEB.


RUNNING DRIFT 0.166 POUNDS PER INCH.
18 b 50 20 f 181 18 j 281 13 n 368
a 10 c 60 50 g 148 86 K 145 116 o 165
RUNNING DRIFT 0.129 POUNDS PER INCH
d 10 e 17 b 50 i 15 l 181 m 12 P 281 q

PLAN OF UPPER SPARS

DRIFT LOADS AND STRESSES IN THE PLAN OF THE UPPER AND LOWER SPARS INCLUDING EFFECT OF STRUT AND WIRE RESISTANCE AND EXCLUDING TENSION OF EXTERNAL DRIFT STRESS IN EXTERNAL WIRES ASSUMED BEARING ENTIRE LOAD



PLAN OF LOWER SPARS.

The upper surface of the spar follows the outline of the R.A.F.6 wing section at this point, but in making computations the slight slope may be neglected.

To compute the moment of inertia, the quickest way is to

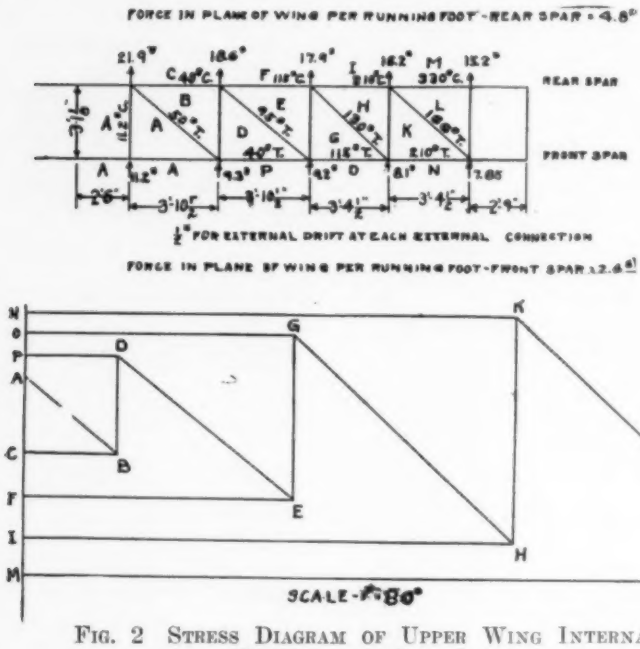

FORCE IN PLANE OF WING PER RUNNING FOOT - REAR SPAR = 4.8
REAR SPAR
FRONT SPAR
FORCE IN PLANE OF WING PER RUNNING FOOT - FRONT SPAR = 2.6
SCALE - 1" = 80

FIG. 2 STRESS DIAGRAM OF UPPER WING INTERNAL DRAG BRACING AT 0 DEG. INCIDENCE

compute for the solid section and deduct the moment of inertia of the material channeled out. The moment of inertia of a rectangle being given by the formula $\frac{bd^3}{2}$

$$I = \frac{1.25 \times 3.08^3}{12} - \frac{.600 \times 2.02^3}{12} = 3.06 - .45 = 2.61$$

$$A = (1.25)(3.08) - 600 \times 2.08 = 3.94 - 1.25 = 2.69$$

The stress in the outermost fibers will now be given by the formula

$f = \frac{P}{A} + \frac{My}{I}$ where P = direct load, y = distance of outer fibers from the neutral axis and f = stress. Since $P = 1105$ lb., $M = 44$ ft. lb. = 528 inch. lb. and maximum $f = \frac{1105}{2.61} + \frac{528 \times 1.54}{2.69} = 725$ lb.

Allowing a maximum fiber stress for spruce of 6500 lb., we get a factor of safety of 8.9, which is in excess of the 7.5 specified by the Army for the front spar.

Similar computations can be carried out for the upper front spar at 16 deg.—since the biggest load is carried at this angle.

It must be pointed out, however, that although the formula $f = \frac{P}{A} + \frac{My}{I}$ is largely used, and is, therefore, perfectly sound on a comparative basis, the factor of safety given by it is not exactly true. Tests on breaking beams by bending show great variations from the above formula, depending largely on sections employed, but special values for moduli of rupture by bending are not available.

For the lower wing, if the same chord is employed as in the upper wing, and the spars have the same dimensions, no computations need be made, since the loads on the lower wing will always be considerably less. Whether with the same chord the lower spars should be smaller than the upper ones is a matter to be determined largely from the manufacturing point of view.

A Complete Example of Wing Analysis Arrangement

In Fig. 4 is shown the complete analysis for the wing structure of a Curtiss biplane. The methods employed in getting out this analysis are substantially the same as indicated above, and the method of presentation is an excellent model.

Computations for Shear in Spars

Wood is so much weaker in shear than in either tension or compression, that it is somewhat surprising that designers do not make computation for shear in the spar web—although spars are always made solid for 2 in. or 3 in. on either side of a supporting point, to allow for the maximum shear occurring at such points.

The maximum longitudinal shear for a beam which is subjected to vertical shear occurs at the neutral axis, and its value is determined by the formula

$$q = \frac{F}{Ib} A_1 y$$

where F = vertical shear at the point due to external loads, I = moment of inertia of whole section, b = breadth of web at neutral axis, A_1 = area of section above neutral axis, y = distance of centroid of this area from the neutral axis.

Thus consider the same upper rear spar 2 feet from the wing hinge. The shear at this point, as given by the shear force diagram of Fig. 7 of the preceding section, is 20 lb. Considering the section of spar shown in Fig. 3:

$I = 2.59$

$A_1 = \text{——} = 1.27$

$b = .625$ in.

$y = .87$ in.

$$q = \frac{20}{2.59 \times .625} \times 1.27 = .87 = 13.6 \text{ lb.}$$

Allowing shearing value of spruce to be 400 lb./sq. inch, we have a factor of safety of 29.4, which is amply sufficient. But cases might occur where the shear near supports is very large, and resistance to shear being largely due to the web, it is always advisable to make such computations.

(Editorial Note.) — With the completion of this section, the Course terminates in its present form. Articles dealing with special points in air plane design in direct continuation of the Course will appear at frequent intervals. The Course is undergoing revision prior to publication in book form.

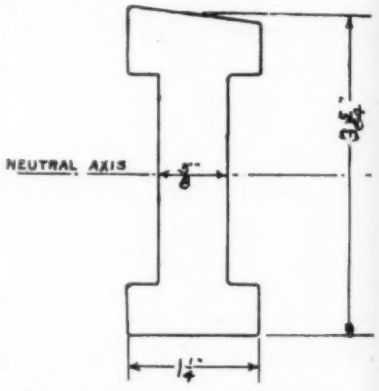


FIG. 3 REAR UPPER SECTION

Aeronautical Patents

Copies of these patents may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."

ISSUED JULY 3, 1917.

1,229,503. Filed August 28, 1916. To Knute W. Olson, St. Paul, Minn. Safety Device for Aviators.

1,229,297. Filed July 21, 1916. To Geo. Lehberger, Newark, N. J. Undercarriage or Chassis for Flying Machines.

1,230,045. Filed Feb. 25, 1913. To Vladimir Skrivanek, Ft. Wayne, Ind. Flying Machine.

1,229,410. Filed Jan. 4, 1916. To John R. Campbell, Austin, Tex. Airplane.

1,229,713. Filed Apr. 24, 1916. To Geo. A. Chaddock, Broad Green, Liverpool, Eng. Mechanical Air-Borne Ship.

1,229,649. Filed Feb. 20, 1917. To Lafayette Pace, LaFollete, Tenn. Safety Appliance for Airplanes.

ISSUED JULY 10, 1917.

1,231,387. Filed Apr. 4, 1916. To Joseph H. F. Laflamme and Omer Gravel, Toronto, Ont., Canada. Bomb Dropper.

1,231,881. Filed Mar. 9, 1917. To Isaac Francis Taylor, E. Dulwich, London, Eng., assignor of one-half to Samuel Peck, London, Eng. Aerial Apparatus for Defense against Hostile Aircraft and for Other Purposes.

1,231,444. To Ruter William Spruger, Springfield, Ill. Wing or Propeller for Aerial Dynamics and other purposes.

ISSUED JULY 17, 1917.

1,232,313. Filed February 10, 1911. To Wilson S. Howell, Jr., New York, N. Y. Aeronautical Device.

1,232,616. Filed Jan. 30, 1913. To George C. St. Louis, Fresno, Cal. Airplane.

1,233,820. Filed Nov. 10, 1916. To Joseph B. Stage, Bold Spring, Tenn. Airship.

1,233,982. Filed Oct. 19, 1916. To Frank Clark, Throop, Pa., assignor of one-half to William Wellon, Throop, Pa. Aeronautical Machine.

ISSUED JULY 24, 1917.

1,234,151. Filed May 17, 1915. To M. M. Goldenstein, Milwaukee, Wis. Motor Controller.

1,234,311. Filed Feb. 24, 1916. To Thomas Smith Duncan, Crayford, Eng. Landing Device for Airplanes and Hydroairplanes.

Testing Moisture Content in Lumber

By Thomas D. Perry

All lumber contains moisture, absolutely dry lumber being impossible, commercially speaking. In small test pieces, or on a laboratory basis, perfectly dry lumber can be obtained. Perfect dryness (often called "bone dry") is a condition in which all moisture has been evaporated, leaving only dry fibre and a minute amount of granular residue from sap (nearly negligible and disregarded hereafter). Lumber with a moisture content (indicated by m. c.) of 5 per cent means that in addition to the dry fibre weight the board contains 5 per cent of water (by weight), or a total of 105 per cent weight compared with 100 per cent dry fibre. In other words, one-twentieth of the dry fibre weight represents the additional weight of water.

There are three principal reasons for testing the moisture content of lumber, as follows:

1. When you buy lumber to be sure you are receiving what you bargained for.
2. When you put lumber in the kiln to ascertain the period of time necessary for drying.
3. To insure properly dried lumber before emptying the kiln.

To prepare for testing a lot of lumber, take a board from the wettest or greenest lumber as it is piled, cut off a piece 24 inches to 40 inches long and dress both edges, calling this a "test board."

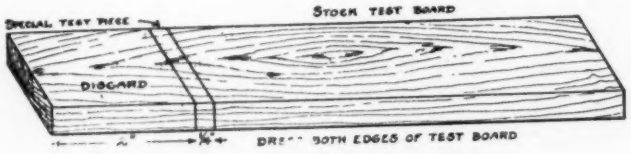


FIG. 1

If the test is preliminary to kiln drying, the test board should be put on a kiln car in such a location that it can be removed through instrument openings in side wall, door or end of kiln. From this stock test board several sections must be taken at intervals in the manner described. (See Fig. 1.)

Cut off about two inches of one end, which always reject, and take another cut ¼ in. long (way of grain) to be used as a special test piece to ascertain condition of lumber. Smooth off edges and corners with a coarse file or sand-paper. One or more test pieces should be prepared as lumber enters kiln, and others as it is thought lumber is ready for removal. When test shows proper per cent of moisture content it may be taken from kiln.

Computation Method Using a Metric Scale

For convenience in figuring the percent of moisture content, scales should be graduated on the decimal system, metric

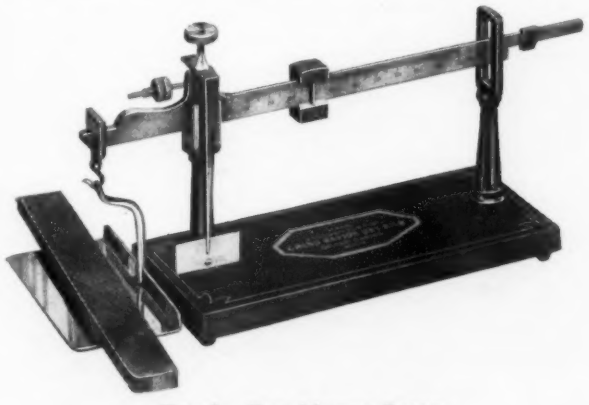


FIG. 2. THE METRIC SCALE

scales answering this requirement admirably. Fig. 2 shows a type of scale especially designed for weighing the lumber, equipped with sliding poises, and without the loose weights that are so liable to be lost. This scale, however, requires computation on the part of the user, and is, therefore, subect to the possibility of human error. The test pieces are to be marked as shown in Fig. 3. The figures above the line indicate the initial weight and measurement taken immediately after cutting out the test piece. The test piece is then reduced to "bone dry," or until it has reached the minimum weight on

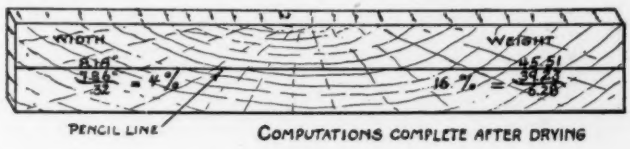


FIG. 3

a heater or radiator. While still hot re-weigh and re-measure, placing final figures below the line. The process of figuring is as follows:

SHRINKAGE		WEIGHT	
Before drying	8.18 in.	Before drying	45.51 grams
Bone dry	7.86 in.	Bone dry	39.23 grams

7.86).3200(.04
3144
56

39.23)6.2800(.16
3.923
2.3570
2.2638
832

= 4% Expansion over bone dry.

= 16% Moisture content over bone dry.

The Computing Scale or Lumber Tester

This is similar to the preceding, but has a chart etched on the scale beam, as shown in Fig. 4, so that moisture content

FIG. 4. THE COMPUTING SCALE OR LUMBER TESTER

can be read directly on the sliding poise. This computing scale, which is also graduated on the metric system, may be used by exactly the same computation method as the metric scale, but for all practical purposes (within a limit of ½ per cent accuracy) can be used by taking even grams and reading off the nearest percent.

Cut one or more test pieces, each ¼ in. long (way of grain), so that the total weight will be between 50 and 100 grams. Brush off splinters and loose pieces. Weigh test pieces immediately after cutting to nearest gram and mark with total weight. Reduce all test pieces to bone dry on engine cylinder, in oven, or on electric heater, until a constant or minimum weight is reached. Re-weigh the identical samples immediately after removing from heat and leave poise at exact weight to fraction of gram. Place pencil or other pointer on chart line at initial weight and follow down and left to final weight where poise stands. The point where chart line meets percentage scale on poise will give moisture content percentage reading on poise. The chart is drawn so that moisture content percentage is computed on basis of bone dry weight, as approved by the Forest Products Laboratory, maintained by the United States Government at Madison, Wis.

To use for exact results the initial weight must be brought to an even gram by slight sandpapering, even though several trials are necessary.

The percentage graduations on poise have finer divisions for percentages under 10 percent, since closer results are required in testing kiln dried stock within this range. Above 10 percent the divisions are for air dried and green stock.

The advantage of the computing scale is its freedom from error in subtraction and division. Anyone can use the scale,

the simplicity of its operation encourages frequent testing, and frequent testing means uniformly dried lumber. Avoid charts, tabulation, or scales in which the computation is based on the initial rather than the final or bone dry weight.

Lumber at best is a variable material, due to processes of growth, and every provision should be given workmen to encourage them in keeping lumber dryness uniform in the woodworking shop.

Purchasing lumber on a moisture content basis is now receiving merited recognition. Green or partly air dried lumber that requires excessive kilning, or even yarding preliminary to kilning, is worth less than well air dried lumber ready for use after a minimum time allowance for kilning.

Lumber is valuable according to the speed with which it can be converted into a finished product. A price penalty for high moisture content in lumber bought and a bonus for a low moisture content would be beneficial to buyer and seller alike. Proper instruments efficiently used will make this possible.

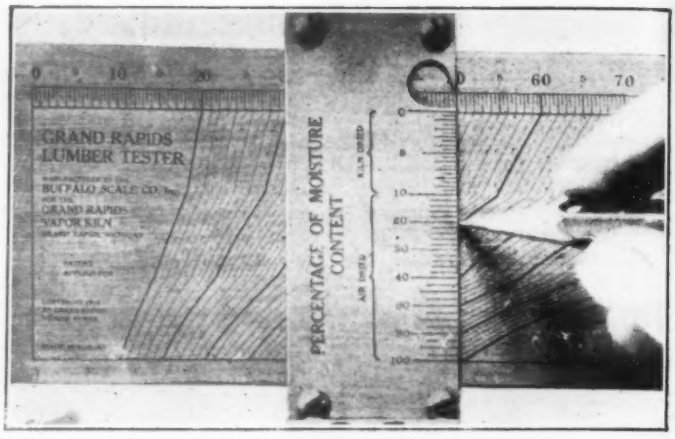
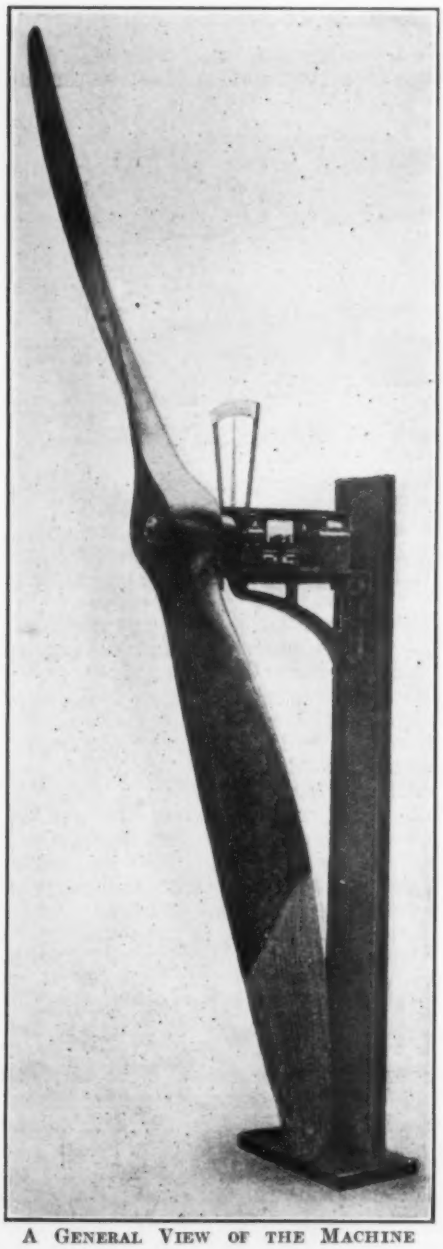


FIG. 5

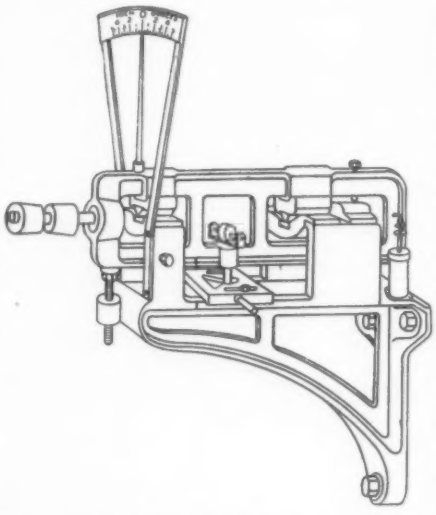
The Avery Propeller Balancing Machine

(From the *Automobile Engineer*)

This machine is designed to supersede the rough qualitative methods usually employed for propeller balancing. It consists of a rocking head having at one end a boss on which the propeller to be tested is mounted, and carrying three knife edges, two pointing upwards and one pointing downwards but all lying in the same straight line. The center of gravity of the head is below the line of the knife edges, so that the moment of unbalance of the propeller is resisted by a moment due to the weight of the head itself. A pointer is fixed to the head, and swings across a fixed scale, recording the amount of unbalance in inch-pounds. The knife edges bear on a bracket attached to a pillar, as shown in the photograph.



A GENERAL VIEW OF THE MACHINE



PERSPECTIVE ARRANGEMENT OF THE BALANCE HEAD

By the use of this machine it becomes possible to entirely avoid cut-and-try methods of adding and removing weight, the exact change which must be made at a given radius being deducible from the scale readings. It may also be employed in balancing the laminations separately before gluing, the effort being made to so arrange the laminations that their lacks of balance will counteract each other, removing the necessity for any weighting or removal of material from the complete propeller.

New City Planning Problems

City planning ideas have been greatly changed, if not revolutionized, by the war. Airplanes and the added needs of transportation and distribution have been partly responsible for this, and there is a note of inspiration in the statement, made by George B. Ford in an article in the *American City*, that France, for example, is going ahead, despite the war, with an extensive program of reconstruction against the coming time of peace. Ruined cities are being rebuilt along modern lines, and older cities are being made over. The French hope for lasting peace, but they propose to profit by the lessons of the recent past and to be ready for any emergency.

It is now seen that the city of the future will require provision for aviation. We may be slow to realize the fact here in the United States, but it will be impressed upon us later, for we propose to take a prominent part in the coming air campaign, and it is inevitable that when we are more familiar with this means of locomotion we will not return to the old ways. Thousands of airplanes will be flying in this country within a few years, Mr. Ford predicts, and the Postoffice Department already, in conjunction with the Aero Club of America, is planning to select appropriate places for landings in or near every important center. In France, aviators from a standing start, go only about 150 yards before leaving the ground, and then shoot up at a surprisingly sharp angle, but they require a field of about thirty acres on which to make a safe landing. Not many cities in the United States are well provided with open spaces suitable for such landings.

The importance of moving large numbers of people quickly from one place to another is accentuated by war, but it is nevertheless not to be disregarded in peace time, while the necessity for extending terminal facilities of every kind is especially impressed upon us by the National crisis. Not only railroads but watercraft require more room for taking on and discharging freight. This fact has been so realized by the French that the important ports are being reconstructed on a large scale. Facilities are being doubled, and in some instances even quadrupled, in size. "Hardly a city in America," remarks Mr. Ford, "is prepared to meet emergency conditions in like fashion." And it is probable that our emergency in this regard will come not because of the war but as the result of peace, when every forward-looking man believes that our trade in materials for the reconstruction of Europe will be increased enormously.

War has emphasized the need of city planning along intelligent lines. It has exposed shortcomings here and suggested improvements there. Even the need of suitable recreation has been emphasized. But greatest stress, if we except the problem of the airplane landing, has been laid on the high importance of docks and railroad terminals, of roads connecting cities, of warehouse facilities and of labor-saving devices for loading and discharging cars and ships. Of these, it would seem, there is no danger of having too much; and American cities, still in a comparative beginning of their growth, can save billions of dollars by taking the lesson to heart in time.

Bureau of Standards Test on Ackerman Wheels

Some recent tests have been made at the Bureau of Standards on the 26 x 3 in. Ackerman wheel, weighing 22 lb. complete.

The tests were made (a) to determine maximum component parallel to the axis, (b) to determine maximum component perpendicular to the axis, and the hysterisis, if any.

Test (a) was performed by holding the hub rigidly and applying the load at the edge of the rim, as shown in Fig. 1. Test (b) is not illustrated, but a similar method was used, the hub rigidly held and the load applied at the top of the rim.

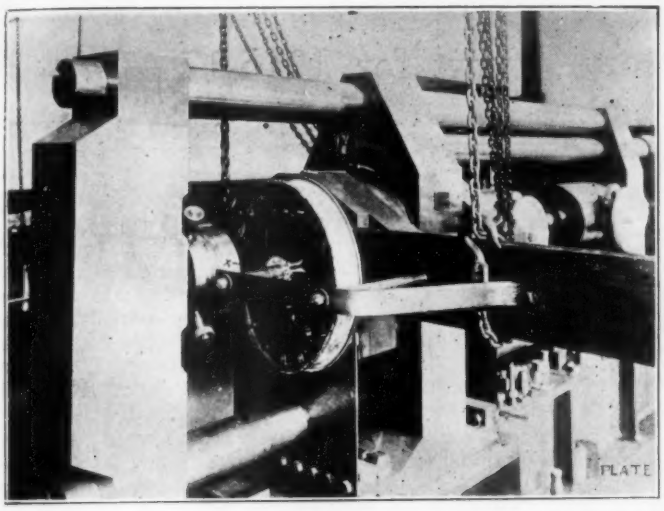


FIG. 1. ARRANGEMENT OF WHEEL ON TEST TO DETERMINE MAXIMUM COMPONENT PARALLEL TO THE AXIS

As shown in Fig. 1 on the first test (a), two bolts marked (x) broke at root of threads. This allowed spokes to slip out, which, in turn, broke the nickle-plated hub plate.

In the second test (b), two spokes broke by bending, and the rim and spokes were permanentlv distorted.

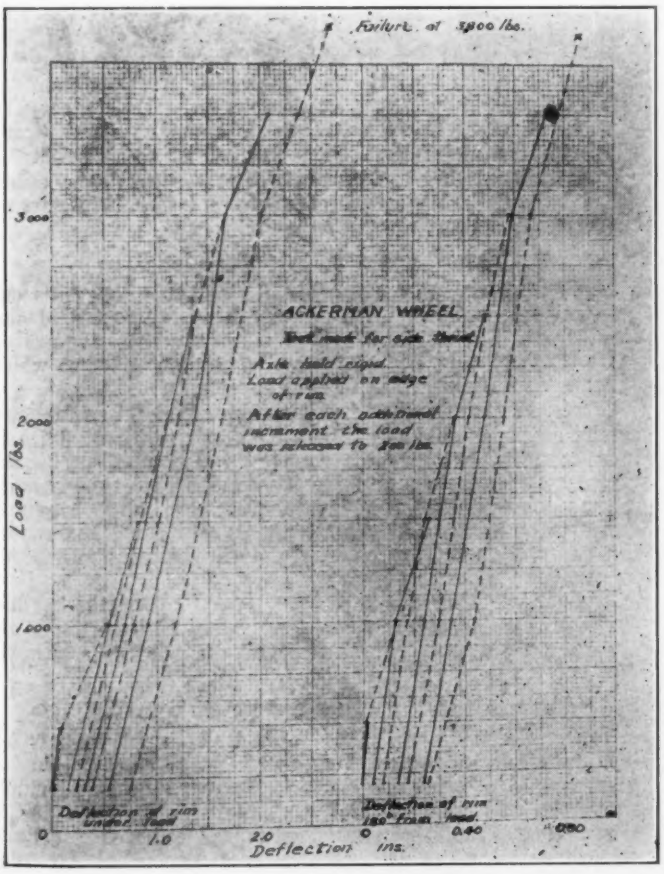


FIG. 2

In each test the load was released after an increase of 500 lb. over that of the previous load. In test (a), measurements

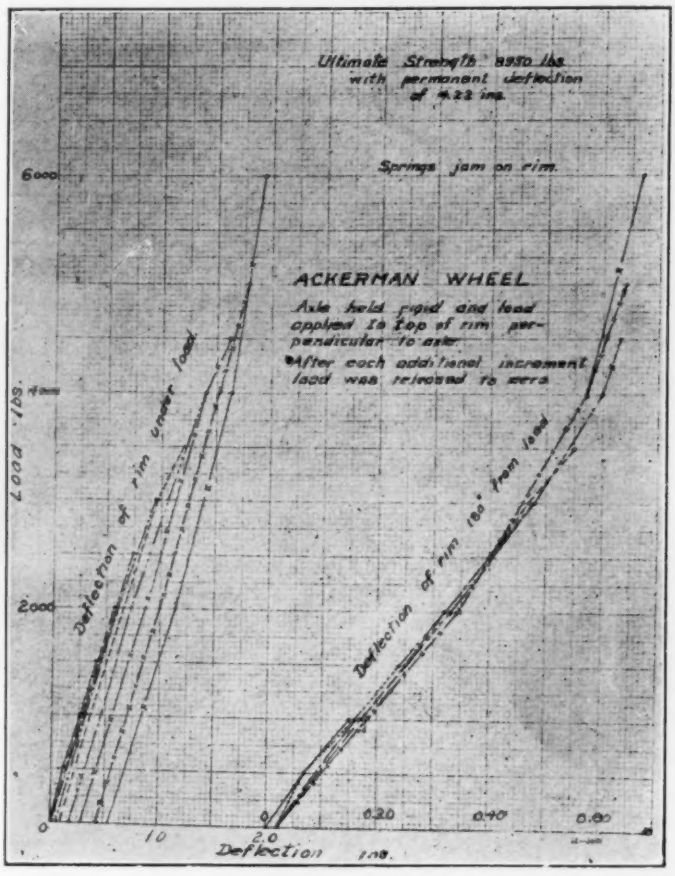


FIG. 3

were made between punch marks on rim and foundation channel. One set of marks was immediately under the point of application of the load, and another was 180 deg. from this point. Measurements for test (b) were made from the rim to a point on the hub directly under the load and 180 deg. from same.

In Fig. 2 are shown curves for test (a), in Fig. 3 those for

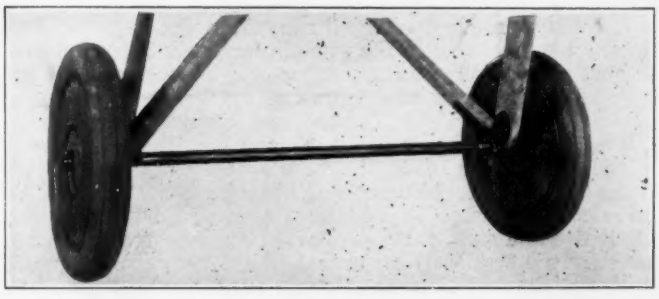


FIG. 4

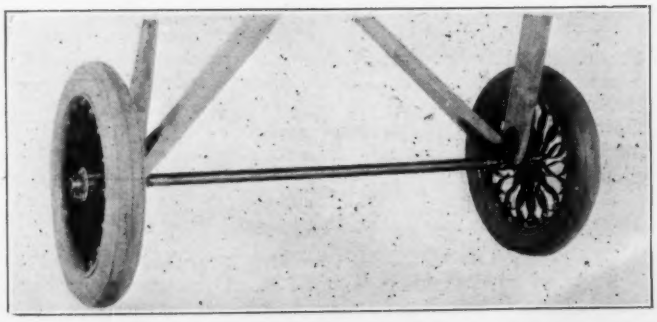


FIG. 5

test (b). After each loading and release there appears to be a set, but the return loop is not shown, so that the hysterisis work cannot be computed. This does not, however, appear to be considerable. The ultimate strengths were 3,800 lb. and 8,950 lb. for the two tests. With these curves in hand, the designer can compute exactly what occurs under any shock on landing.

Figs. 4 and 5 show the simple mounting of this wheel on the axle.

Excellent performance has been secured with this wheel in actual field tests in landing, getting away and running over uneven ground. A test made February 13 last at Mineola, L. I., by Capt. A. W. Briggs, formerly of the British Royal Flying Corps, is thus described in a letter from Captain Briggs:

"In a test flight today at the United States Aviation Field, Mineola, Long Island, I flew a Curtiss type J.N.4 military biplane No. 76, equipped with Ackerman wheels. The test was to determine the qualities of the Ackerman wheel.

"After making several landings in bad ground, stalling and dropping 5 to 6 ft. upon several of the landings, and then taxi-ing rapidly over very rough surface, I wish to say that the wheels proved to do all that was claimed for them and more, as their resiliency perfectly absorbed all shock before it reached the axle, causing the machine to hold the ground after a drop, and have little or no tendency to bounce as is the usual case in such landings.

"Over bad ground the uneven surface was, to all intents and purposes, smoothed out causing easy riding to the machine."

National Physical Laboratory Report for 1916-17

The annual meeting of the General Board of the National Physical Laboratory was held at the Laboratory at Teddington, Eng., June 19th. The President of the Royal Society (Sir J. J. Thomson) is chairman of the board, and Lord Rayleigh is chairman of the executive committee.

During the past year the laboratory has been closely engaged—with a largely augmented staff, of whom more than one hundred are women—with a variety of researches and investigations arising out of the war, and has dealt with a greatly increased volume of test work for government departments. Out of the wealth of reports we select the following, dealing with or bearing upon aeronautical work:

The Effect of Surface Roughness on the Heat Transmitted from Hot Bodies to Fluids Flowing Over Them

According to the Reynolds theory of heat transmission the heat transmitted from a hot surface to a fluid flowing over it for a given velocity of flow and difference of temperature is proportional to the frictional resistance between the fluid and the surface. Previous investigations at the laboratory and elsewhere have fully demonstrated the truth of this theory for the cases of commercially smooth surfaces, and owing to the considerable attention which is now being devoted to increasing the efficiency of radiation of air-cooled engines, it was considered to be of importance to determine whether the considerable increase in frictional resistance which would be obtained by artificially roughening the surface would be attended by a corresponding increase in the heat transmitted. The necessity for such an experimental investigation is apparent from the consideration that the Reynolds theory is based on the convection of heat due to turbulent motion, and that in cases in which the resistance is due to eddies on a larger scale, such as those thrown off from the edges of a thin plate normal to the current, its application may not be valid. A series of heat transmission experiments was accordingly undertaken with two brass pipes identical in all respects except that in one the internal surface was in the smooth drawn condition in which it was received and in the other the internal surface was roughened by means of a screw-cutting tool so as to form a series of sharp ridges. Water was circulated through the pipes by means of a centrifugal pump provided with suitable speed regulation so that the mean velocity of flow could be varied from 15 to 100 cms. per second. The outside of the pipe was surrounded by insulated coils of Eureka wire connected to the supply mains through variable resistance, and so arranged that the temperature of the pipe could be maintained at the desired value above the temperature of the water. The mean surface temperature of the pipe was measured by an extensometer specially designed for the purpose. For the estimation of the initial and final temperature of the water, thermojunctions in thin brass tubes were placed in the water at the extremities of the experimental length and connected to a potentiometer. The estimation of the flow of water through the pipes was obtained from a carefully calibrated meter. Observations of the frictional resistance of the pipes were made by the usual method. The investigation is not yet completed, but sufficient evidence has been obtained to demonstrate that for the degree of roughness of the pipe used the Reynolds theory can be applied for all practical purposes.

Equipment

The new wind channels, 4 and 7 ft. in diameter respectively, which were reported to be almost complete at the close of the last annual period, have been in continuous use for almost the whole of the current year. In both it has been found possible to obtain air speeds of 80 ft. per second with the more powerful motors installed, and the steadiness of the current is quite satisfactory when the supply is steady. In the early months difficulties were experienced from very sudden changes in the frequency of the supply voltage to the laboratory, which caused much inconvenience. The steadiness has since been greatly improved by the supply company, and the electrical plant rendered suitable for accurate work by careful attention to the voltage regulator installed in the generator room of the division. In the evenings the control so obtained is sufficient to render unnecessary continuous hand regulation of the air speed during an experiment.

The channels and balances of the new equipment were carefully set up independently of results obtained in the older channels. The speed standard was, as before, the standard National Physical Laboratory anemometer calibrated on the whirling arm to the nearest 0.1 per cent. of velocity. After setting up in this way, a standard wing section was tested, and the results were found to agree with those in the earlier channels. The same accuracy of agreement was found in a comparison made by the Massachusetts Institute of Technology and by the Royal Aircraft Factory, who followed National Physical Laboratory methods. The absolute accuracy of the methods appears to be established as of a high order.

New methods of test have been developed during the year in order to deal with new requests; the difficulty of the experiments called for is steadily increasing, and greater complexity in the models has made it important to consider new methods of holding them, so as to get the necessary mechanical strength without undue aerodynamical effects, which may be large unless the utmost caution is observed.

It is believed that the new methods have now been established beyond the experimental stage, and will form part of the accumulated experience of the division.

Experiments on Airship Models

Much work on the resistance and stability of airships has been carried out during the year, both on the non-rigid and rigid types. The results when applied in practice have proved to be very valuable, having led to the economy of time which follows from the success of the first attempt.

Work on screens for the shielding of airships has also received considerable attention. The structure of eddies is very complex, but methods have been devised whereby the necessary observations and records can be made. The more advanced results of the investigation are now becoming available and will shortly reach the stage at which a report can be made on the motion of the air in the neighborhood of an airship shed and screen.

Further investigations have been carried out on the equilibrium of kite balloons in direct connection with their use on the full scale, and modifications have been indicated which are now commonly adopted.

Experiments on Models of Airplane Wings

The work on aerofoils has covered the usual field, which includes work on new sections, the effect of combinations of planes and, in particular during this year, the aerodynamic properties of triplanes. Deformations of wing form due to the sagging of the fabric have been reproduced on a model and the variation of wing characteristics dependent on such deformations has been determined.

Experiments on Complete Models of Airplanes and Seaplanes

The results in the 7 ft. channels have proved that the increased scale and speeds made available do not lead to appreciably different results from those obtained in the smaller channels. The advantages of a larger section of channel are considerable in dealing with complete model airplanes as the mechanical accuracy of construction can be carried to further length.

The number of tests on complete models has again been considerable, and recently two very accurate and complete models have been constructed, one at the National Physical Laboratory, and the other at the Royal Aircraft Factory, on which work will continue for comparison with full scale observation of stability and performance.

The results so obtained are also useful for the calculation of the motion of an airplane when maneuvering or when looping, conditions in which the aerodynamical conditions react directly on the stress problems connected with aeronautics. General methods of dealing with the strengths of air planes and propellers come up for consideration from time to time and where necessary the calculations are supplemented by additional experiments directed towards the determination of the forces acting. The conditions of flight are continually changing and are accompanied by fresh problems requiring solution.

Test on Airplane Bodies

The experiments under this head refer more particularly to the body as forming part of the whole airplane structure. The conditions of shape are fixed partly by aerodynamical considerations but on the whole more by the size of engine employed. The increase of resistance of the body due to the slip stream from the propeller is important, and for both pusher and tractor types has been made the subject of direct experiment.

Stability

In this section very little new ground has been broken, but the applications and detailed analysis have received much attention. Some work has been carried out on the stability of kites and kite balloons in addition to that of airships which has already been referred to.

Propellers

A number of propellers have been tested during the year, mostly in a wind channel, but occasionally on the whirling arm. The subject of the airflow round a propeller has been investigated from the point of view of design, and the investigation has led to an addition to the theory of design which is expected to ensure greater certainty in producing a propeller which is suitable for a special purpose. The work has given an explanation of a large part of the empirical design factors which have been used in the past. The theory in its new form has a direct bearing on the problem of the helicopter, and shows reason for large errors in applying the older methods of calculation to the problem of direct lift.

Special Investigations

During the year an analysis has been made of the performance of airplanes as measured by tests on the full scale. The conclusions reached are of very direct practical application, and it is hoped that they will lead to improved performance by directing attention to the salient features of importance in the design of a modern airplane.

Calculations have been made of the trajectories of aerial bombs, and the experiments on radiators have been continued.

Alloys Research

To a large extent, the work on aluminum alloys, which has been carried on throughout the year with the greatest possible energy, has been devoted to the immediate practical requirements of aircraft construction. A very large amount of work has been carried out and a long list of reports on a number of points of first-rate importance has been submitted, in the first place to the Advisory Committee on Aeronautics and to the various Admiralty and Army authorities concerned with aircraft construction. More recently the Advisory Committee on Aeronautics has formed a sub-committee to deal with light alloys, and on this sub-committee the laboratory is represented by the superintendent of this department. The work of this sub-committee is already making itself felt in a considerable increase in the amount and urgency of the work required of the department in connection with light alloys. At the same time it is gratifying to find that a considerable number of these results, thanks to the activity of the sub-committee and the representatives of the Air Board upon it, are finding immediate translation into practice. The work of the department in this connection may, therefore, reasonably claim to have assisted to a material extent in the development of the very marked improvements, particularly in aeronautical engines, which have been achieved during recent months.

During the year there has also been a marked revival in connection with those aspects of work on light alloys which have been carried on under the auspices of the Alloys Research Committee of the Institution of Mechanical Engineers. Much of this work overlaps and interlocks with the work required for immediate aircraft purposes, but, thanks to the grants from the Alloys Research Committee of the Institution of Mechanical Engineers, and, through them, from the Industrial Research Department, it has been possible to investigate a number of matters of broad and fundamental interest in connection with the whole question of aluminum alloys and their future use and development.

Offer Spruce for Airplanes

As a result of a conference held at Washington between authorized representatives of spruce manufacturers of Oregon and Washington and representatives of the Signal Corps, the Aircraft Production Board, the British, French, and Italian missions now in Washington, and the lumber committee of the National Council of Defense, Howard E. Jayne and F. A. Douty, of Oregon, proposed on behalf of the spruce men to furnish aircraft spruce for the coming year's big program at $105 per 1,000 feet. This price is about one-half that which has been paid up to now by many of the airplane manufacturers. The price applies to the allies' needs as well as to those of the United States.

If it is finally approved by Government authorities it will, in the opinion of the lumber committee, unquestionably result in a big saving on spruce requirements.

Specifications Proposed

The specifications which have been proposed by the spruce men and which received the informal approval of the Government's representatives present are as follows:

Thickness.—2 in. to 6 in., inclusive. At least 60 per cent to be 2 in. and 4 in. thick. Not more than 40 per cent 2 in., 5 in. and 6 in. thick.

Width.—All to be 4 in. and wider, not over 10 per cent under 5 in. wide.

Length.—Fifty per cent to be 19 ft. and longer. Fifty per cent to be 4 ft. and longer.

Measurement.—Width and thickness fractional. Lengths in multiples of 1 ft.

Grain.—All lumber 3 in. and thicker shall be not less than 70 per cent vertical grain of an angle of 45 deg. to 90 deg. on each carload. All lumber 2 in. thick shall be not less than 30 per cent vertical grain of an angle of 45 deg. to 90 deg. on each carload.

Grades.—The grades agreed to are as follows:

Grades Agreed Upon

The 50 per cent of all lumber 18 ft. and longer shall be clear four sides, straight grained, not less than six annular growth rings for each 1 in., sound and well manufactured, free from shakes, spiral and curly grain.

This grade will admit of bright sap, wane, pinworm holes, slight variations in sawing, or other defects that will not impair its usefulness for wing beams.

The 50 per cent of all lumber 4 ft. and longer shall yield clear cuttings, straight grained, not less than six annular growth rings per each 1 in., sound and well manufactured, free from shake, spiral, and curly grain; some may contain knots, pitch pockets, wane, pinworm holes, slight variations in sawing, and other defects that will not impair its use for the purpose intended, providing, however, that each piece must produce, for buyer, clear straight grain, cuttings from 4-ft. to 17-ft. lengths, which shall not include over 5 per cent of such cuttings 4 ft. to 7 ft., inclusive.

Anti-Aircraft Control System

A board of officers to consist of Maj. Elmer J. Wallace, Coast Artillery Corps; Maj. Charles T. Richardson, Ordnance Department; Capt. Jacob M. Coward, Coast Artillery Corps, Detached Officers' List; and Capt. George R. Allin, Field Artillery, Detached Officers' List, is appointed to meet at Fort Monroe, Va., at the call of the senior member to investigate and report upon anti-aircraft fire-control system which will be common to both branches of the Artillery.

$640,000,000 Appropriated for Army Aviation

On July 24 President Wilson signed the bill appropriating $640,000,000 for the enlargement of the Air Service of the Army. We give herewith two statements, one by Brig.-Gen. George O. Squier, Chief Signal Officer, and the other by Howard E. Coffin, chairman of the Aircraft Production Board, outlining as far as it is possible to do so, the plans of those charged with the expenditure of the appropriation:

Statement of Gen. Squier

"I am not here to make public our plans or to indulge in prophetic figures. The closest estimate I can give is about this: That the Allied Governments have determined to enter Germany by the air route and the United States Government is going to provide enough machines to make itself felt in putting this program through.

"That is not saying that we will construct 22,000 airplanes or 1,000,000 or ten or a dozen. If I knew how many machines we would or could construct in a year I wouldn't tell, because it would be telling von Hindenburg, and he'd thank us for the information. The best time to tell the enemy about any military program is after that program has been carried out.

"Germany announced her 42-centimetre guns by hauling them up to the battle line and firing shells of hitherto unheard of caliber into Belgium. After the guns were built and placed and in operation she encouraged the press in glorifying the results. The Germans are a nation of press agents, but they never let publicity tamper with a Government secret.

Air Route Into Germany

"Of course the public wants to know what we are going to do with the $640,000,000 which Congress has appropriated for the aviation service. Well, it's safe to say that we will spend that money and probably much more on the air route into Germany. That's about all we are going to say.

"Civilians are continually asking, 'What are your plans?' It's hard to convince some business men that an efficient military program is not a plan, but many plans. It ought to include all the plans there are in order to meet and defeat the fellow on the other side of the firing line, and you may be sure he has not been advertising his intentions.

"The public ought to be educated in the psychology of war, to be taught the swift opportunism which must be employed in carrying out any great military enterprise. The essence of strategy is surprise. In many respects war is the polar opposite of regular business, as business is generally considered. The captain of industry schemes out his work, sometimes looking years ahead. He plans to operate in settled communities, or communities whose growth and condition can be fairly well calculated. But the very spirit of warfare is shift, change, impermanency. A General on the field is working against a hidden foe whose science and wit are constantly employed for the wrecking of that General's plans.

"How, then, could I say, if I would, what America's aviation program will be for the next six months or a year? If you will show me von Hindenburg's provision for air attack during the coming winter and spring, then I might divulge a few Yankee plans to counter it.

Cost from $9,000 to $75,000

"People who are so cocksure about our determination to build 22,000 airplanes seem to be inspired with the notion that aeros are all made on the same pattern, turned out of the factory as alike as two cubes of sugar. As a matter of fact airplanes vary in cost between $9000 and $75,000; and a comprehensive aerial program must include everything from a simple school machine to a flying dreadnaught. New inventions are continually being tried out, new appliances and models must be installed in order to keep up with the times—or a little ahead of them.

"The German General Staff—that mysterious body working and thinking all the time somewhere between Berlin and Constantinople—isn't going to let things remain at a standstill over there, and we may be called upon to revise our whole system in order to wreck theirs. That is war, which, as I have explained, is the most elastic thing in the world.

"A recently cabled report quotes the German commander of aviation as saying that American aviators will fail, among other things, through lack of courage. That German, obviously, has never encountered an American flier in action."

Mr. Coffin's Statement

"The program must be carried out with a promptness equal to that displayed by Congress in passing the measure. It is a task demanding all the initiative and power of American industry for its consummation, and, just for that reason, one to which the nation will respond.

"All world's records for industrial development of a new art must be broken. Whatever crimes may later be laid at the door of those who are to direct this work, that of inaction or slowness in accomplishment must not be one of them.

"We are prepared to go ahead at once with the expanded plans which the appropriation makes possible.

"One word of caution only need be said here. Under ordinary conditions at least a year would be required for the industrial preparation which this program demands. Yet we have no such length of time in which to perform the task now.

"In spite of our previous inexperience in quantity production of fighting planes we must have thousands of them for next year's use to make the contribution which the allies expect of us.

Must Await Results

"It must be remembered, therefore, that a few months will necessarily elapse before the outward results of our industrial effort will show in the shape of quantities of finished fighting machines.

"It may be announced, however, that most gratifying progress on this preliminary organization already has been made during the last few weeks, and if it progresses in the future at the stride that has been developed there need be no fear as to America's position in the aircraft field by next summer.

"Within a comparatively short time we shall have enough of the type required for training the thousands of men who will constitute a contribution to the winning of the war equal in importance to the production of machines.

"America is the last great reservoir of material for war pilots as well as for airplanes. Already three of the twenty-four big new training fields are completed and instruction on them has begun. Others are being rushed to completion.

Orders Placed

"Orders for training machines were placed weeks ago, and shipments of the first output already have been made. The output of this most necessary type will continue to increase rapidly, as we already have plants experienced in their manufacture.

"One hundred and ten thousand officers and men—an army of the air greater than our standing army of a few months ago—will be needed. The whole project is one which appeals to the imagination of our people and to the genius of our American engineers."

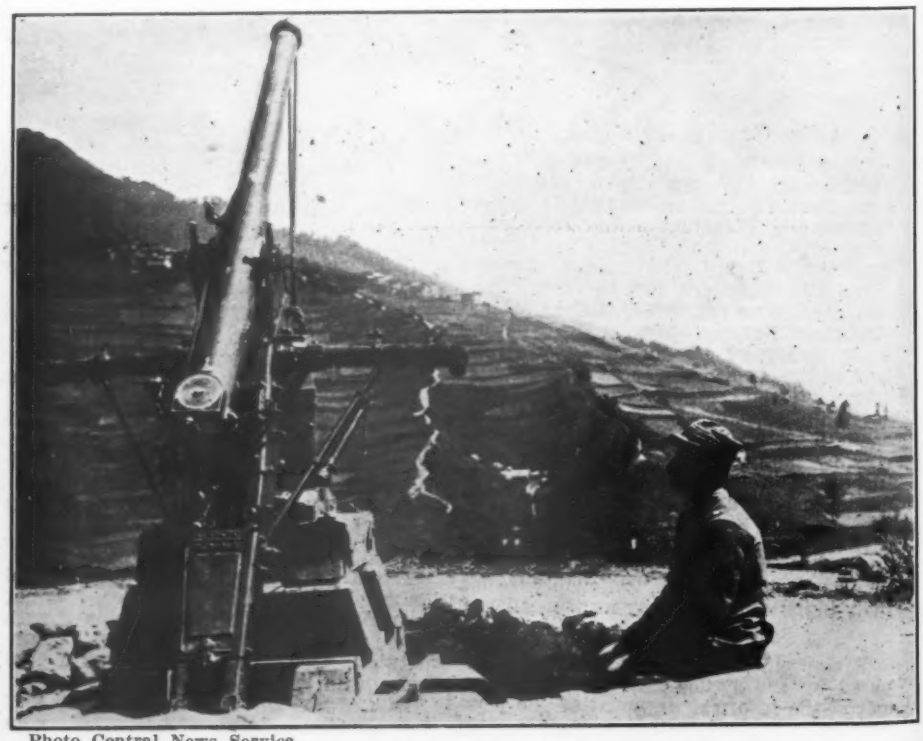


Photo Central News Service

ANTI-AIRCRAFT GUN ON THE ITALIAN FRONT

Manufacturers Aircraft Association, Inc., Organized

In view of several erroneous statements which have been made in the public press, relative to the Manufacturers Aircraft Association, AVIATION prints the following statement issued by the Chairman of the Publicity Committee, Fay L. Faurote:

At a meeting held July 24 in the law offices of Crisp, Randall & Crisp, well-known patent attorneys, the air manufactures of the United States pooled their patent interests for the good of the Government and formed a new organization known as the Manufacturers Aircraft Association, Inc. By the terms of their agreement the various patents owned by the individual members are to be taken over and so cross-licensed that their use may be made universal to all engaged in the industry.

This action comes as a result of a number of conferences held in Washington by the members of the National Advisory Committee for Aeronautics and the officials of the Army and Navy and the Manufacturers Aircraft Association.

In January, 1917, the Secretary of War and the Secretary of the Navy requested the National Advisory Committee for Aeronautics to investigate the aircraft situation and recommend a solution for the problem in patent litigation which had arisen between the Wright-Martin Corp. and the Curtiss Aeroplane & Motor Corp. As a result of these meetings a special sub-committee on patents was established at a regular meeting of the Executive Committee on February 10, consisting of Charles D. Walcott, chairman; S. W. Stratton, S. D. Waldon, and Lieut. J. H. Towers, U. S. N. In May, 1917, Judge W. Benton Crisp, Frederick P. Fish (Mr. Fish was not able to serve, and therefore Charles Neave, his partner, acted in his place) and Dr. W. F. Durant were added to the sub-committee on patents, the latter serving as acting chairman.

Previous to this time, Howard E. Coffin, chairman of the Aircraft Production Board and a member of the Council of National Defense, and Sydney C. Waldon, of the Aircraft Production Board, had had several conferences with the aircraft manufacturers, and at the time of the Aeronautic Show in New York suggested an association which later was formed under the name of the Aircraft Manufacturers Association. Meetings were held in Washington on March 23, June 18 and July 10, 11 and 12, to which representatives of the aircraft manufacturers were invited.

After many weeks of consultation and deliberations between the interested parties an agreement was drafted by Mr. Crisp and Mr. Neave and reported to the Executive Committee of the National Advisory Committee for Aeronautics, which agreement was finally approved by the Executive Committee.

When these negotiations were started the task of bringing all of the parties interested together seemed insurmountable, but actuated by patriotic impulses it was finally agreed at the last regular meeting of the Aircraft Manufacturers Association held in Washington, that the cross-licensing agreement and license be completed, and a recommendation made for the formation of a corporation under the laws of the State of New York to be known as the Manufacturers Aircraft Association, Inc.

This recommendation was followed and for the purposes of keeping the organization free from partisan influences in order that the best interests of all stockholders thereof might be managed and directed during the first five years of its existence under a definite and fixed policy, it was decided to place the control of the association in the hands of three voting trustees, consisting of Judge W. Benton Crisp, Joseph S. Ames, professor of the Department of Physics of Johns-Hopkins University, whom it will be remembered was recently sent abroad by President Wilson as a member of a commission delegated to investigate scientific subjects, and Albert H. Flint, the vice-president of the L. W. F. Engineering Company and vice-president of the Aircraft Manufacturers Association.

Of these three, one represents the Manufacturers Aircraft Association, Inc., one the Curtiss and Wright interests, and the third is a neutral elected by the other two.

The directors of the Association are: Frank H. Russell, of the Burgess Co. of Marblehead, Mass.; Albert H. Flint of the L. W. F. Engineering Co.; John P. Tarbox of the Curtiss Aeroplane & Motor Corp.; Harry Bowers Mingle of the Standard Aero Corp.; B. S. Foss of the Sturtevant Aeroplane Co.; George H. Houston of the Wright-Martin Aircraft Corp.; H. E. Talbot, Jr., of the Dayton-Wright Aeroplane Co.

The officers of the Association are: Frank H. Russell of the Burgess Co., president; Albert H. Flint of the L. W. F. Engineering Co., vice-president; Harry B. Mingle, of the Standard Aero Corp., treasurer; Benjamin S. Foss of the Sturtevant Aeroplane Co., secretary and Benjamin L. Williams, assistant secretary.

Judge W. Benton Crisp, one of the trustees, well known as Henry Ford's attorney in the Selden patent case, the counsel for Curtiss in the Wright vs. Curtiss litigation and representative of the Hudson interests in the Hudson crank shaft case, was retained as general counsel.

By the terms of the cross-licensing agreement any responsible manufacturer of aircraft, or one who intends to become a bona fide producer of same, or any manufacturer to whom the United States Government has given a contract for the construction of ten more airplanes, or any person, firm or corporation owning or controlling United States patents relating to airplanes may become a party to the voting trust agreement, provided for in the by-laws, and can qualify as a member.

It is the purpose of the association not to curtail, but to open up the industry in order that the Government officials and airplane manufacturers may not at this time be under any improper or unfair restraints.

All patent litigation relating to airplanes between members of the association ceases automatically, and the airplane industry is therefore left free to expand to any limits desired or required by the unusual demands of the war.

Goggles for Aviators

A goggle designed for use by aviators has several interesting features, different from anything previously produced. The glass used in this goggle has been tested by the Underwriters' Laboratory of Chicago and by the Army and Navy and other Government Laboratories and found ideally suited for the purpose it is intended.

The glass is called "Resistal," and is manufactured by Strauss & Buegeleisen, Warren Street, New York. It is made of two pieces of glass with an intervening layer of celluloid, welded together in such a manner as to form one perfect whole, which is waterproof and not affected by any conditions of heat, cold or moisture. The edges of the glass are not sealed and nothing is used in the manufacture that is affected by moisture or air.

The glass is bent to conform to the curvature of the face and gives an extreme limit of side vision as well as an unobstructed vision in either direction. Less than five degrees of vision at the side are cut off by the goggle.

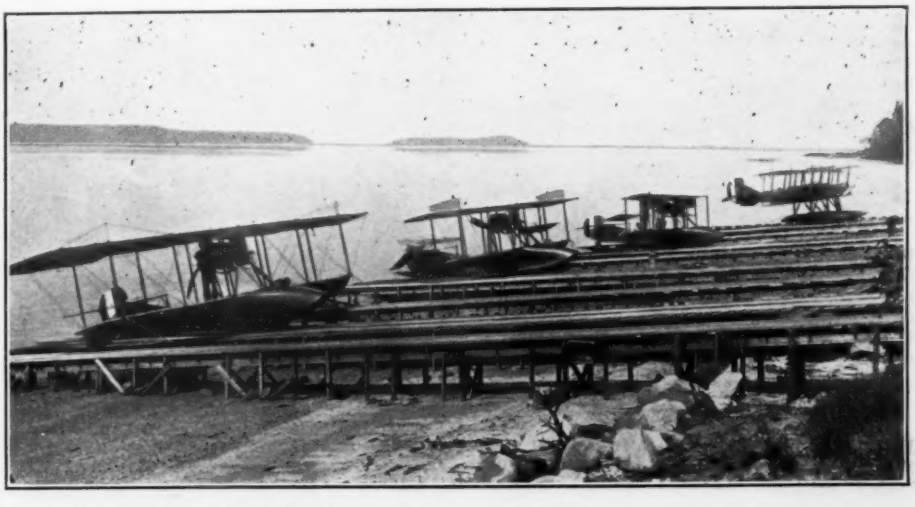
The frame is extremely comfortable, warm and durable and is made to fit any face. A cushion of rubber is mounted as a pad in addition to the usual velvet silk chenille providing a comfortable bearing.

If cracked by a blow or concussion, no particles become detached and there can never be flying pieces of glass, no matter how badly the glass may be hit. Even after it is cracked, it remains airtight and watertight. It does not discolor, scratch or distort the vision and is as transparent as an ordinary sheet of glass.

This glass can also be made in any desired colors, such as amber, euphos or smoke.

Major Foulois Head of Airplane Division

Major Benjamin D. Foulois has been named chief of the airplane division of the Army.



(C) American Press Association

CURTISS FLYING BOATS IN ACTIVE SERVICE

New Curtiss Flying Boat

The new Curtiss model H S-1, a flying boat built for coast patrol work, had its trial flight July 24. Piloted by Harold Kantner, with Wallace Bugh as passenger, the machine left Buffalo at 9.15 a. m., arrived at the Toledo, Ohio, Yacht Club at 1.05 p. m., left Toledo at 5 o'clock and landed at the Detroit Motor Boat Club at 6 o'clock.

On the return trip the next day, in face of a head wind, and with weather conditions so foggy that the pilot was compelled to follow the winding American shore of the lake, and with no attempt at speed, the machine, which left Detroit at 9.15 a. m., arirved at Angola, on the outskirts of Buffalo at 2.40 p. m.

The new model is powered with a 200 h.p. Curtiss engine, which worked perfectly on the trial flight.

Manufacturer's Specifications

GENERAL DIMENSIONS:		
Wing span—upper plane	59 ft.	4 in.
Wing span—lower plane	45 ft.	8 in.
Gap between wings	90 in.	
Depth of wing chord	75 1/16 in.	
Stagger	0 deg.	
Length of machine, overall	38 ft.	6 in.
Height of machine, overall	14 ft.	3 in.
Angle of incidence	4 deg.	
Dihedral angle	0 deg.	
Wing curve	R.A.F. No. 6	
AREAS:		
Wing, upper	370 sq. ft.	
Wings, lower	256 sq. ft.	
Ailerons, each	54 sq. ft.	
Rudder	25 sq. ft.	
Elevators, each	24.9 sq. ft.	
Vertical stabilizer	34.9 sq. ft.	
Horizontal stabilizer	63.9 sq. ft.	
Total supporting surface	626 sq. ft.	
Loading (weight carried per sq. of supporting surface)	6.7 lb.	
WEIGHTS:		
Net weight — machine empty	3215 lb.	
Gross weight — machine and load	4205 lb.	
Useful load	990 lb.	
Fuel, 100 gal.	610 lb.	
Oil, 8 gal.	60 lb.	
Passenger	160 lb.	
Pilot	160 lb.	
	990 lb.	
PERFORMANCE:		
Speed, maximum	73 m.p.h.	
Speed, minimum	52 m.p.h.	
Climbing speed (from actual test)	500 ft. in 3 min.	
ENGINE:		
Model	V 2-3	
Horsepower (rated at 1400 r.p.m.)	200	
Weight per rated hp	3.45 lb.	
Fuel consumption per hour per brake hp	.54 lb.	
Fuel tank capacity	100 gal.	
Oil tank capacity	8 gal.	

W. A. Morgan Manager of Curtiss Co.

William A. Morgan of Buffalo, retiring president of the Buffalo Copper & Brass Rolling Mill Company, becomes the vice-president and general manager of the Curtiss Company in general charge of its business and operations.

John N. Willys of the Willys Overland Company has been elected president of the Curtiss Company, Mr. Willys has also been elected a member of the executive committee to succeed Harry Evers of Buffalo, resigned.

Mr. Morgan's record in handling the phenomenal growth of the Buffalo Copper & Brass Rolling Mill Company under its strenuous war demands is high evidence of his ability to meet the requirements of the Curtiss Aeroplane Company's coming expansion.

Aviation Boards Appointed

A board of officers to consist of Maj. Henry H. Arnold, junior military aviator, Signal Corps; Capt. Henry W. Harms, junior military aviator, Signal Corps, and Capt. Lewis H. Brereton, junior military aviator, Signal Corps, is appointed to meet in Washington at the call of the senior member for the purpose of examining such officers of the aviation section of the Signal Corps as shall appear before it to determine their fitness for rating as junior military aviators.

A board of officers to consist of Lieut. Col. William Mitchell, aviation section, Signal Corps; Capt. Milliard F. Harmon, Jr., junior military aviator, Signal Corps; and Capt. Davenport Johnson, junior military aviator, Signal Corps, is appointed to meet in Paris, France, at the call of the senior member for the purpose of examining such officers as may appear before it to determine their fitness for rating as junior military aviators.

Prof. L. S. Marks to Have Charge of Engine Investigations

The National Advisory Committee for Aeronautics has just secured for an indefinite period the services of Prof. Lionel S. Marks, head of the combined departments of Mechanical Engineering of Harvard University and Massachusetts Institute of Technology. He will be assigned to assist in the special work of the Sub-committee on Power Plants, and will, have charge of certain investigations relating to airplane engine design conducted by this committee at the Bureau of Standards.

Professor Marks is a recognized expert in thermodynamics, engine cycles, and particularly the gas engine, and is probably the best qualified man in the country to supervise the important investigations proposed.

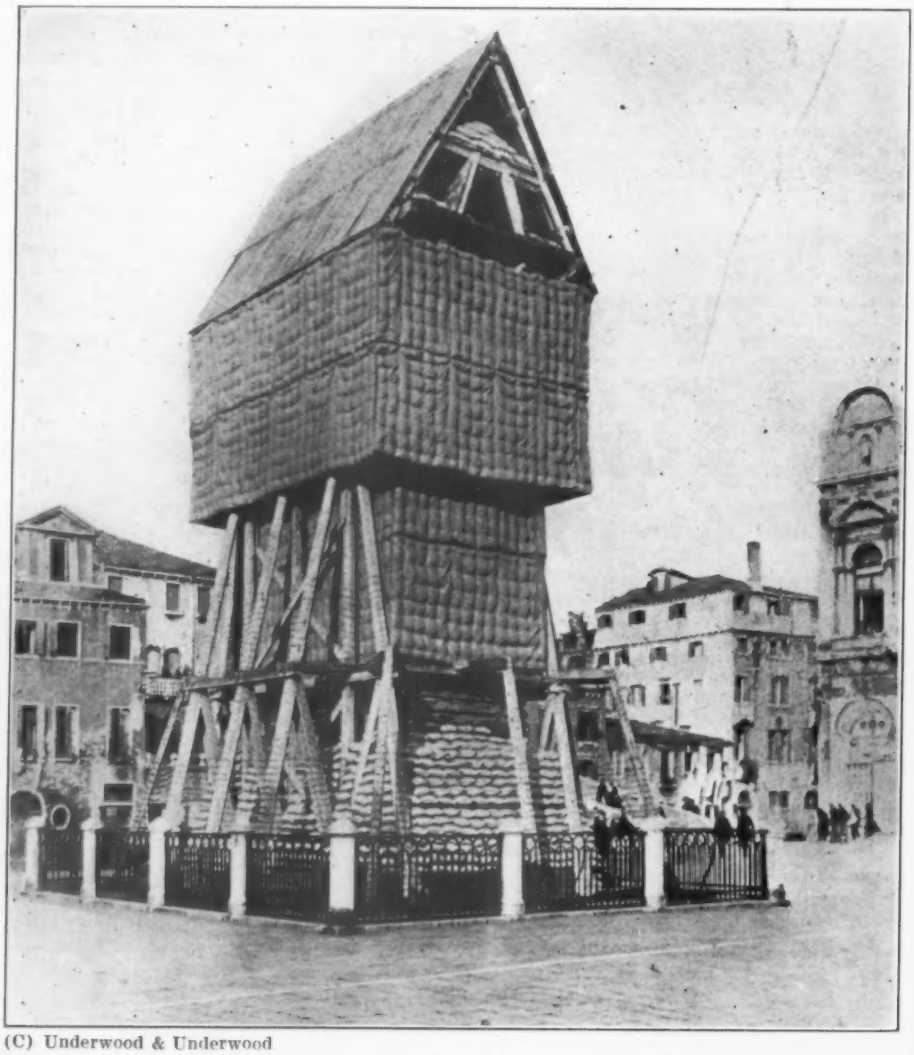
Army Wants Aviation Observers

It is desired to obtain in service in the Aviation Section, Signal Officers' Reserve Corps men qualified for training and commission as observers from airplanes. Candidates for this position should be from twenty-five to thirty-five years of age, should have a good education and be physically fit. Keen eyesight is essential. Ability to draw, and judge distances are desirable features. He should be well balanced and have good judgment, and if possible previous military experience.

It will be the intention to assign successful candidates to a school for periods of instruction of from three to four months. This course of instruction will cover study of artillery, fire from airplanes, reconnaissance, photography, radio and bomb dropping.

Candidates who desire to make application for this position should write to Airplane Division, Chief Signal Officer, War Department, Washington, D. C., who will furnish them the necessary information and blanks for making application to take examination.

Candidates who complete the course successfully will be commissioned as First Lieutenant, and will be eligible to promotion. The pay carried by this commission is $2,000 per year with an increase of 25 per cent when engaged in the duty of observation officer.



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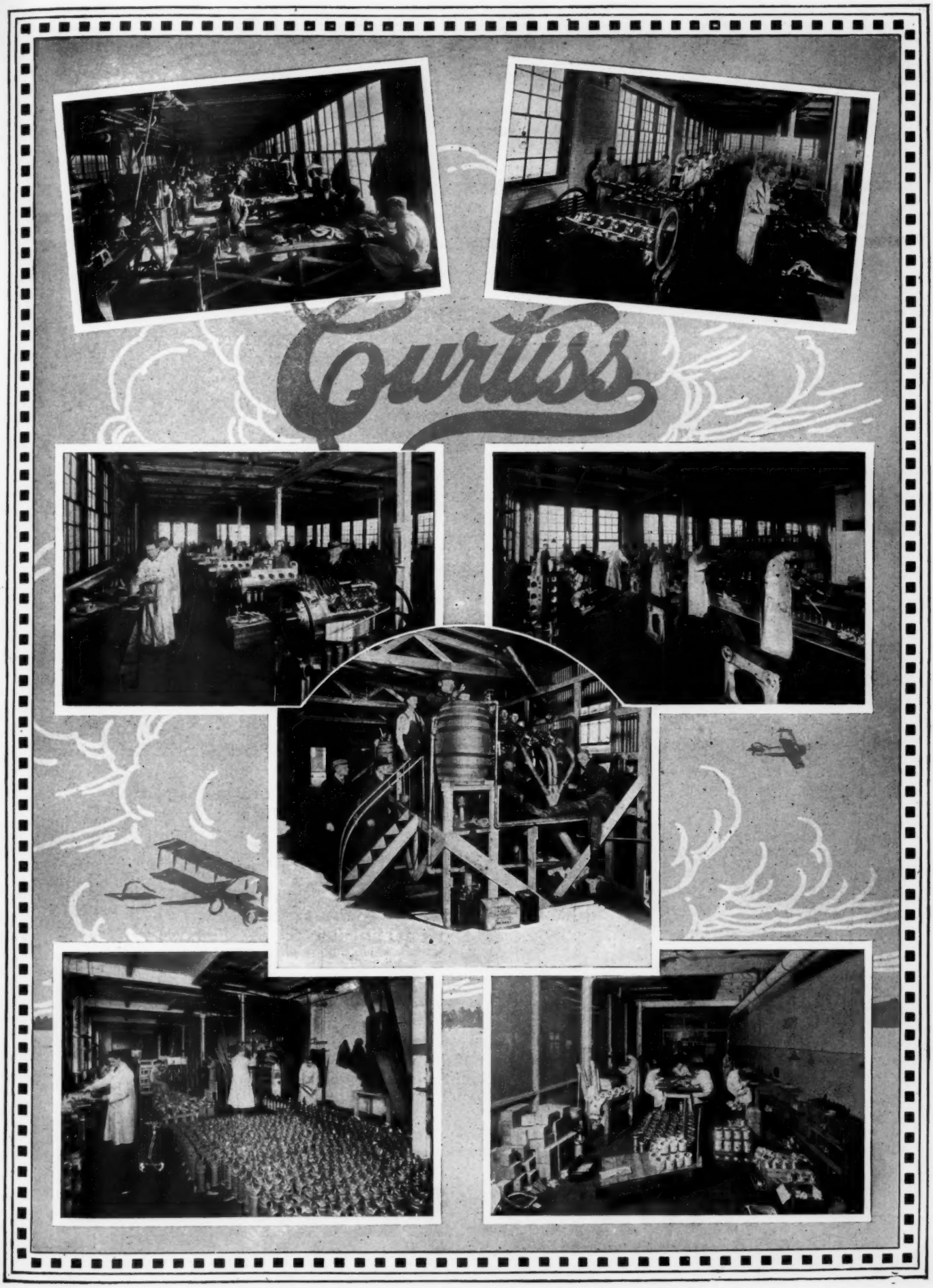
THE COLLEONA MONUMENT IN VENICE PROTECTED FROM AIRCRAFT ATTACK BY SAND BAGS



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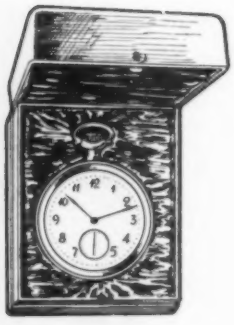
AEROL

A practical quality oil for aeroplane motors



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* * *

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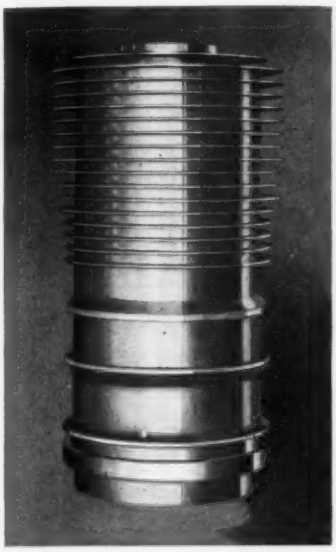

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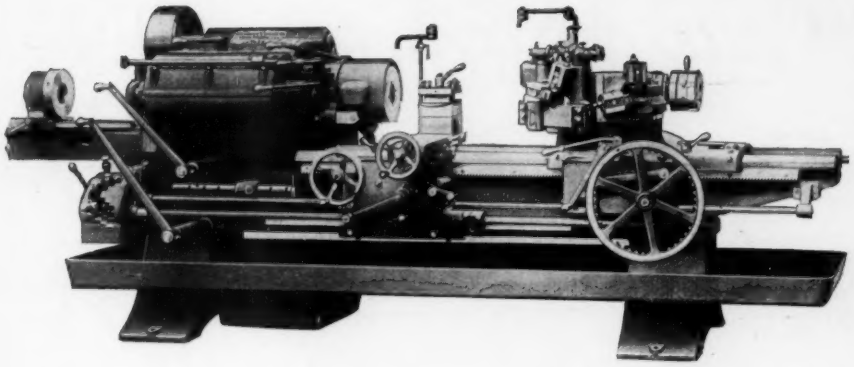

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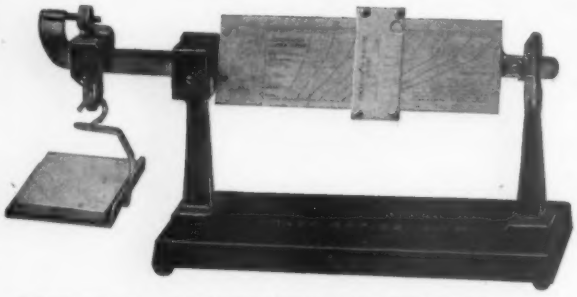

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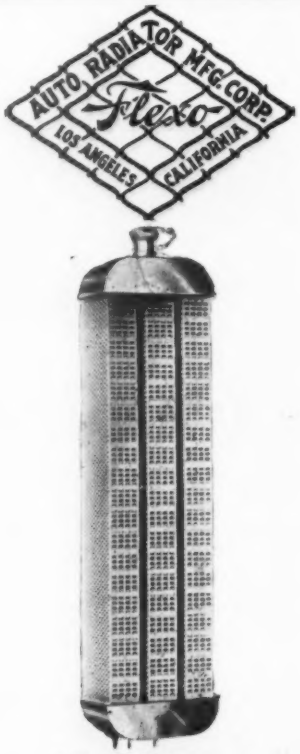

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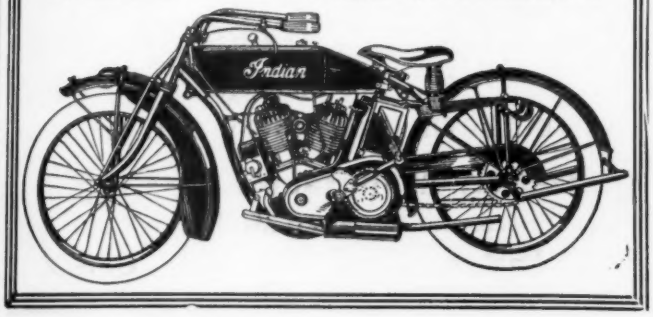

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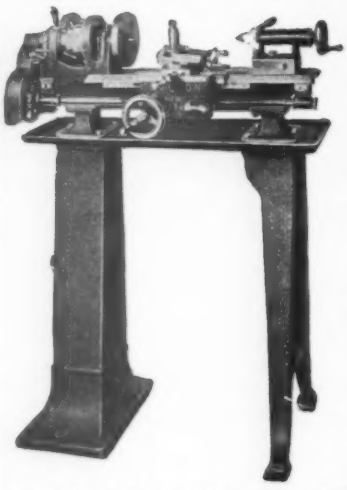

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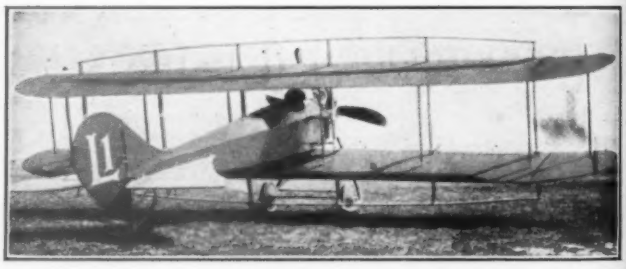

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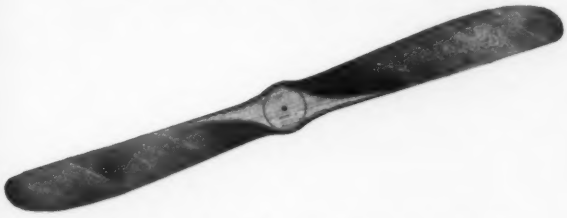

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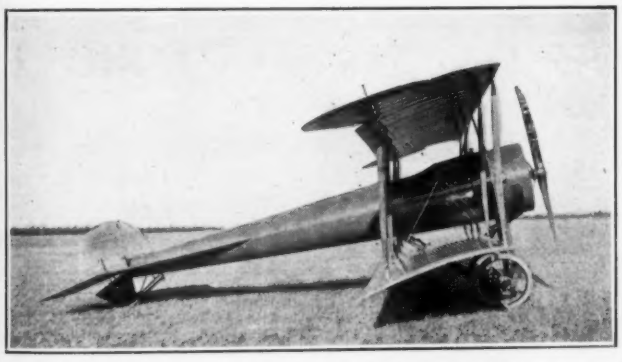

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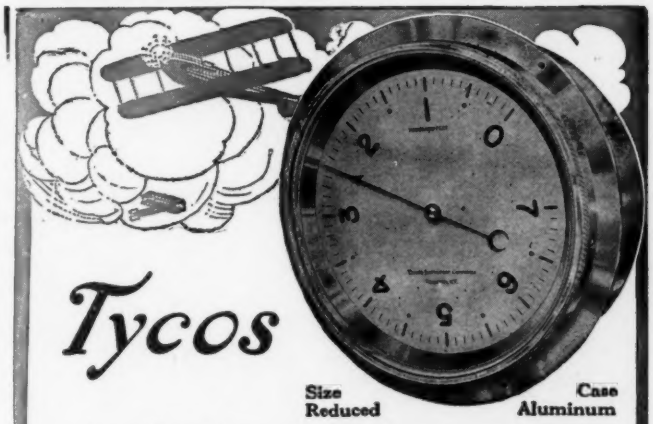

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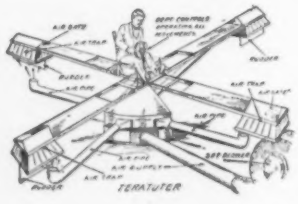

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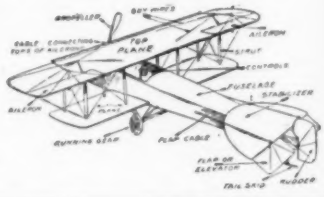

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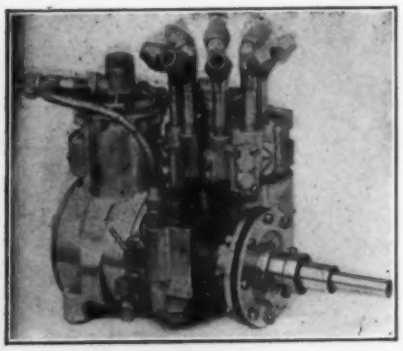

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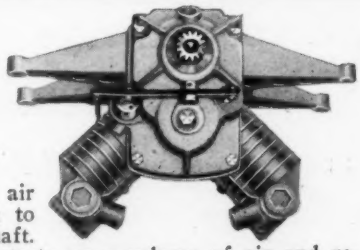

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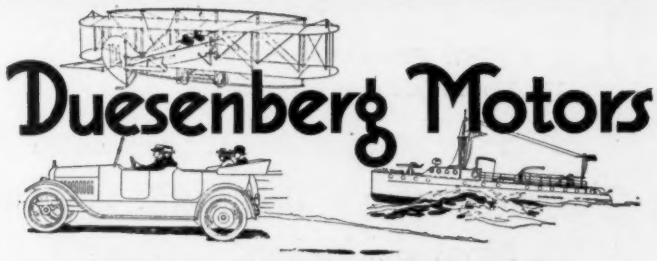

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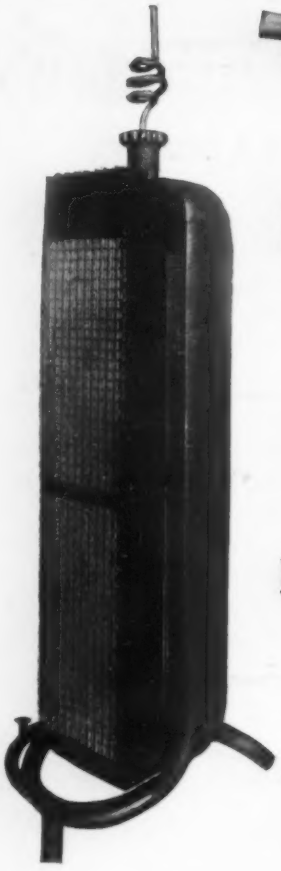

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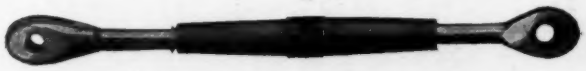

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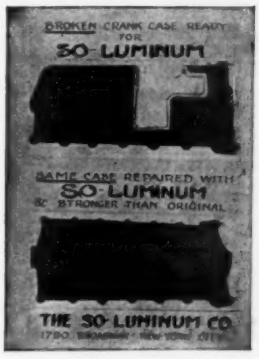

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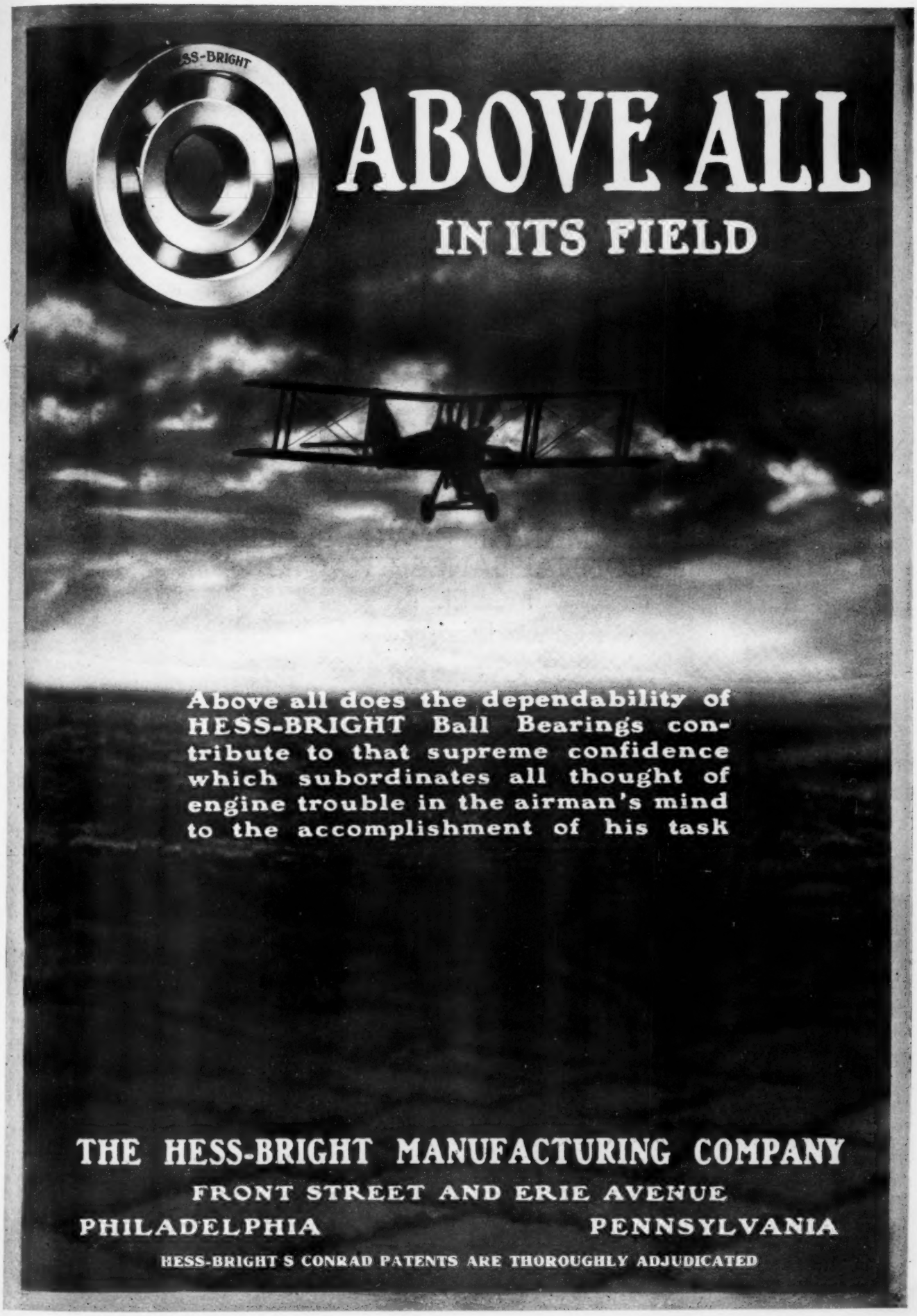
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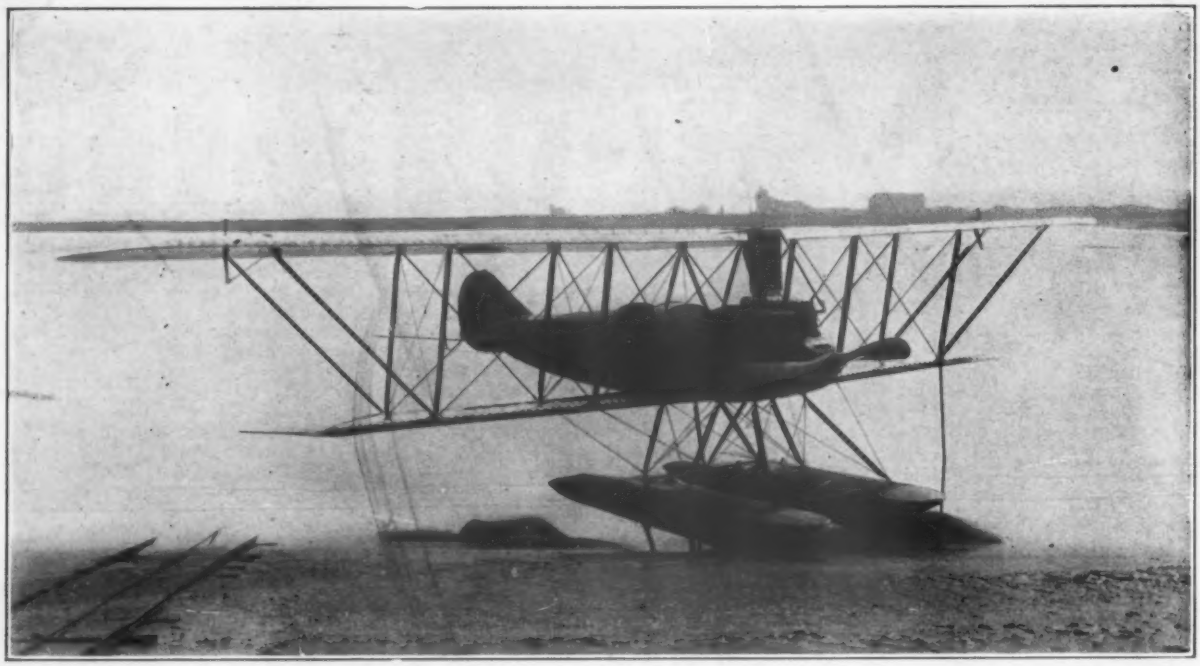

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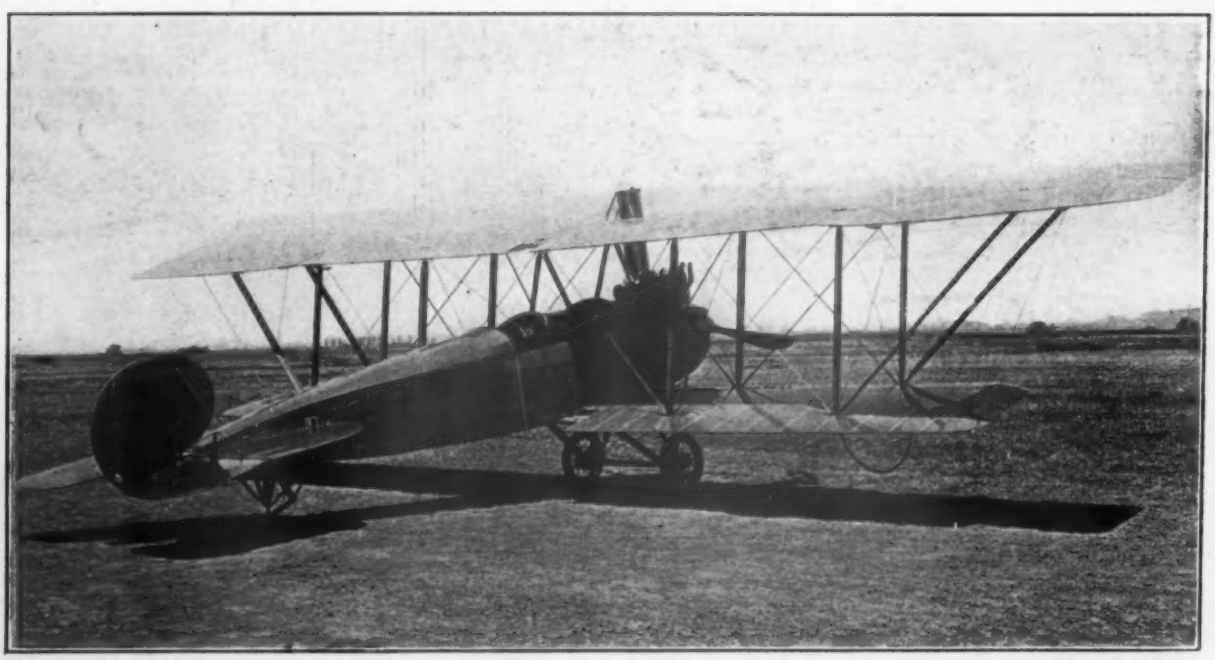
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